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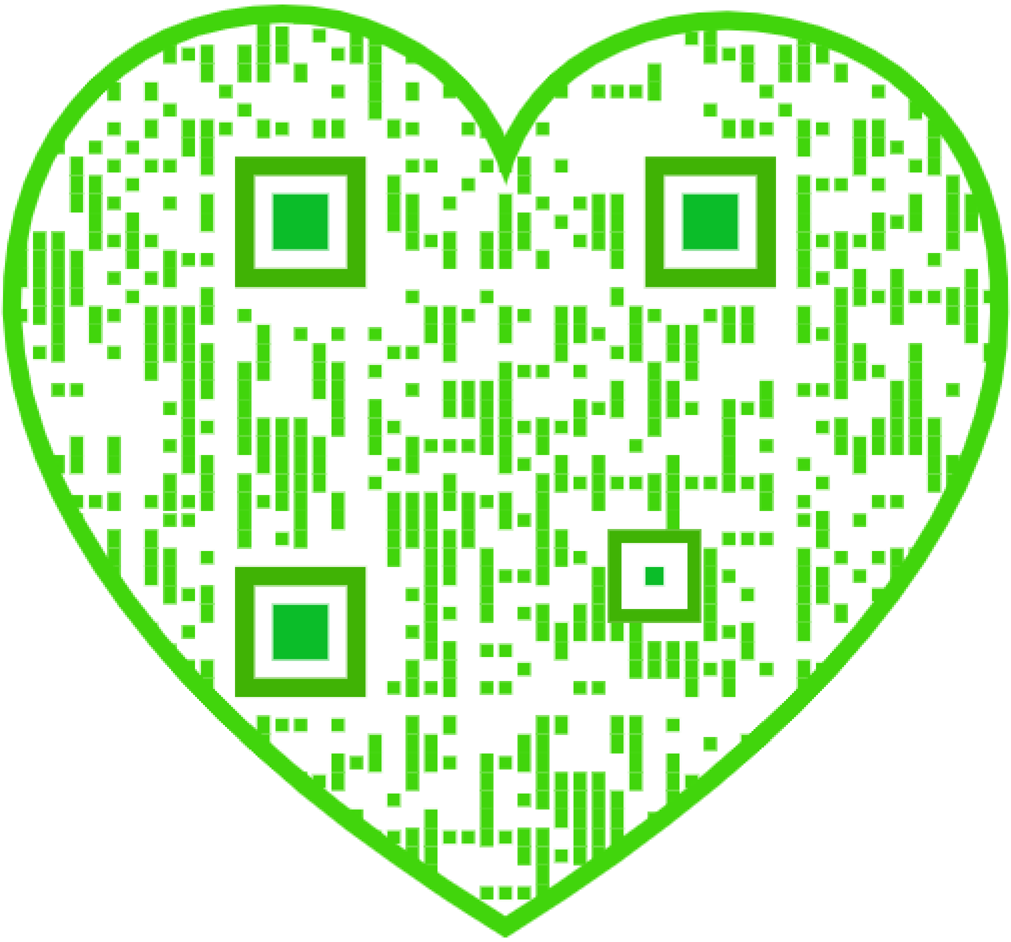

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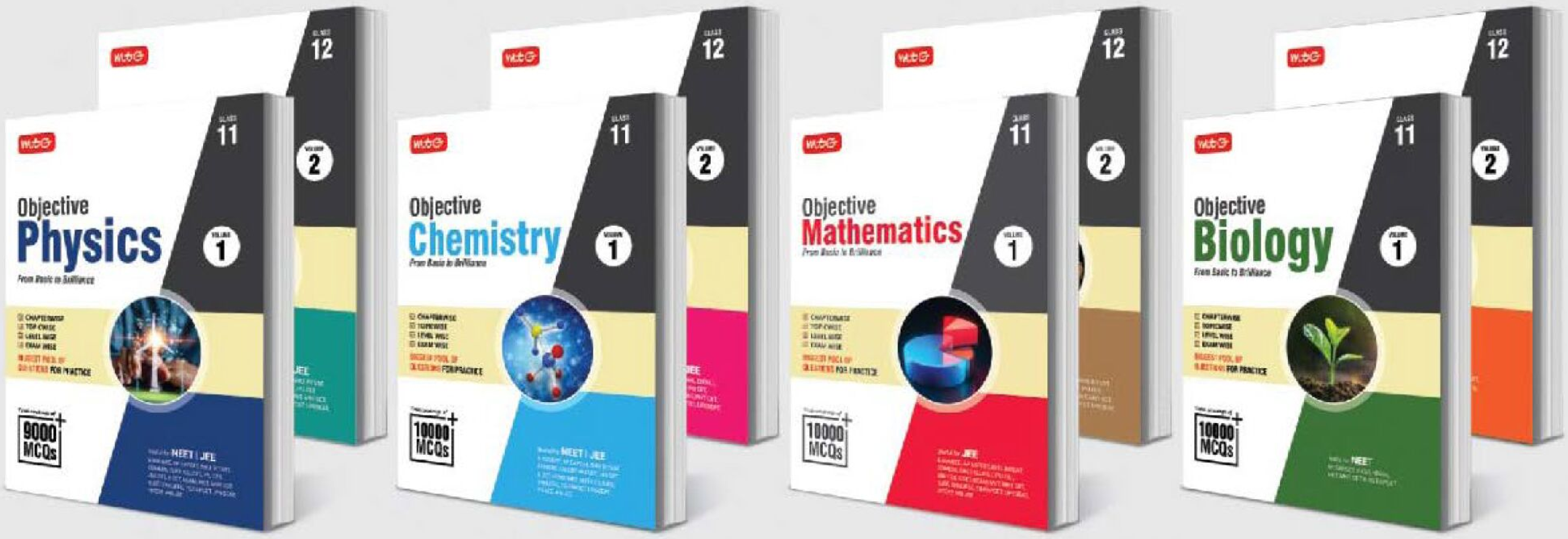

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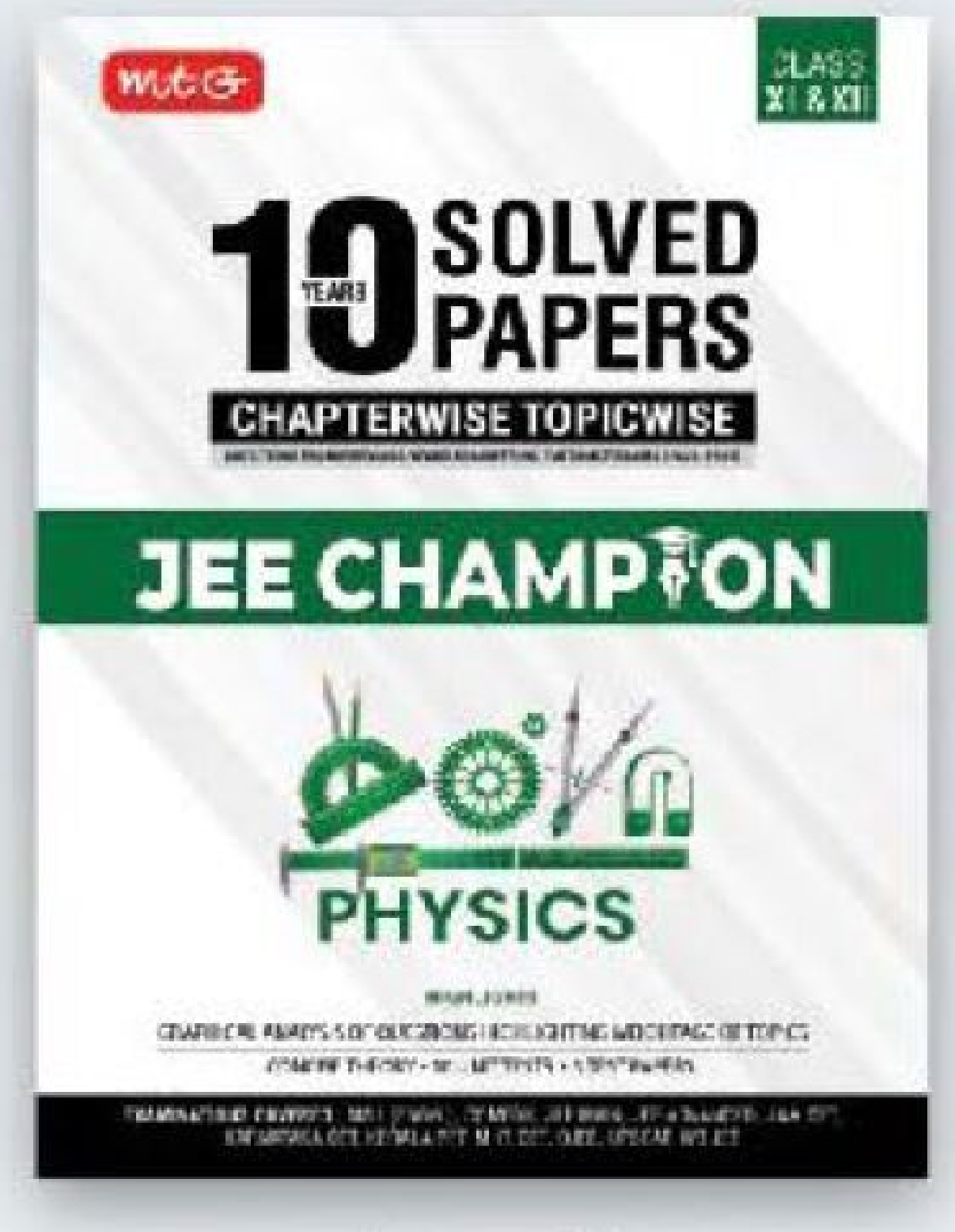
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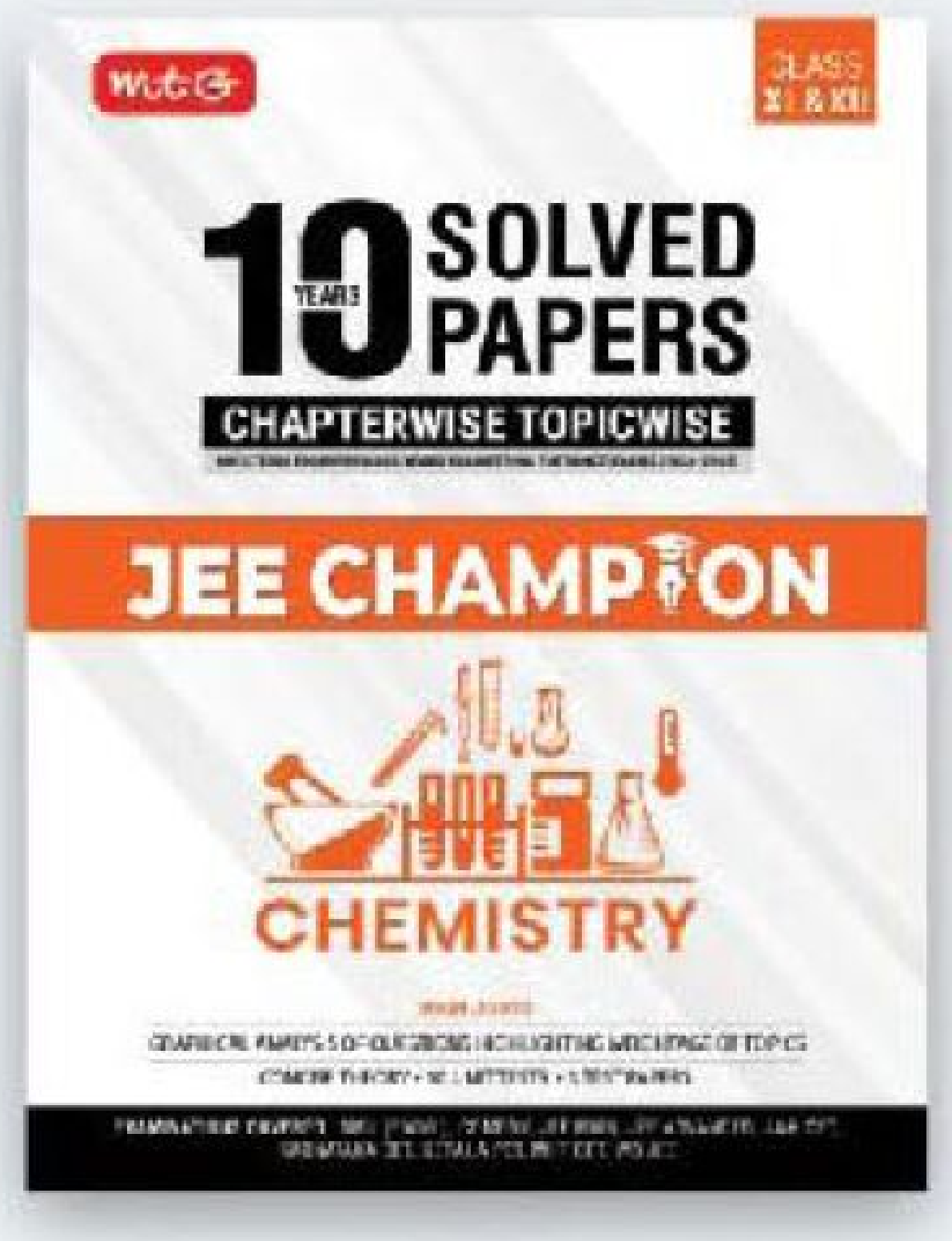
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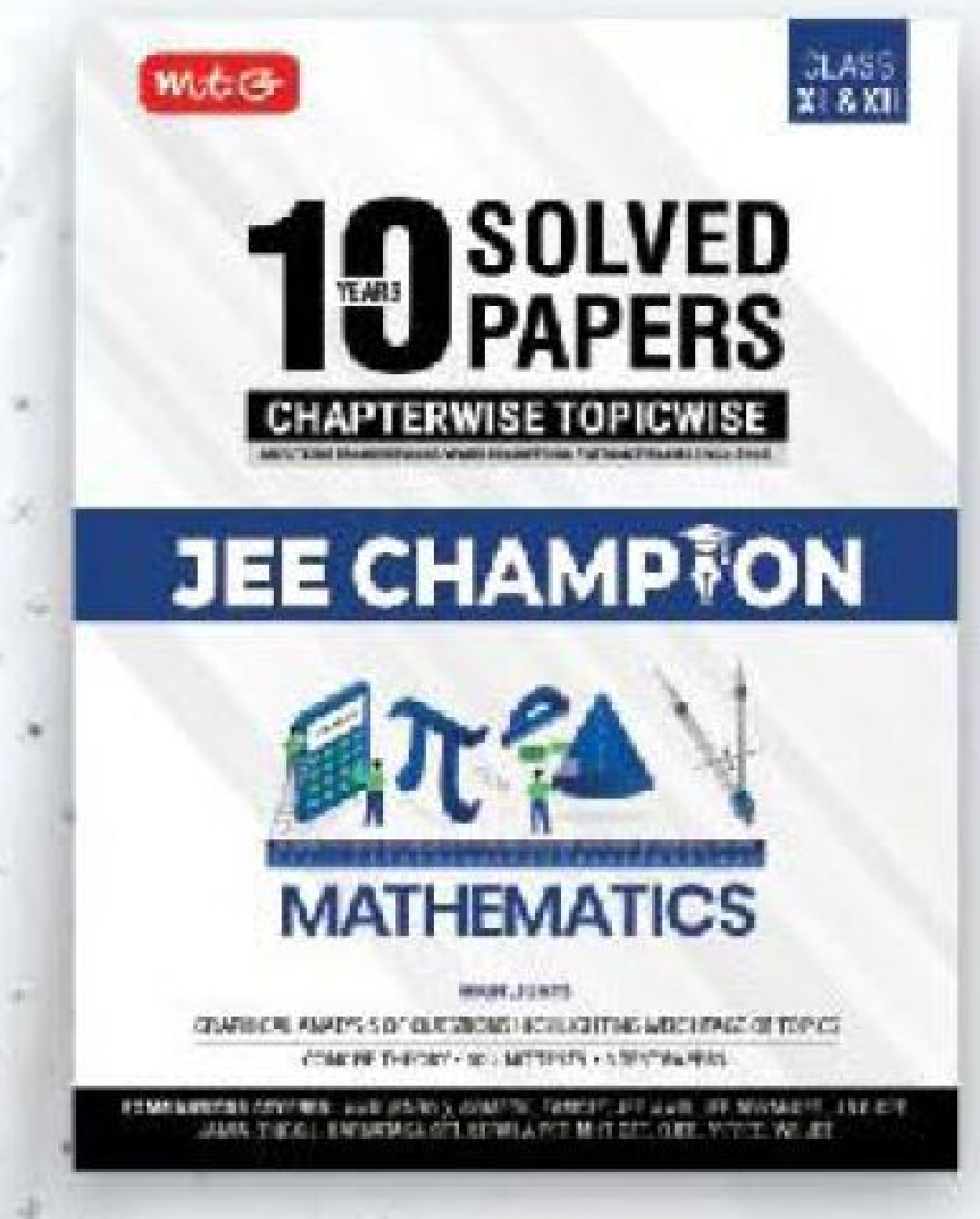
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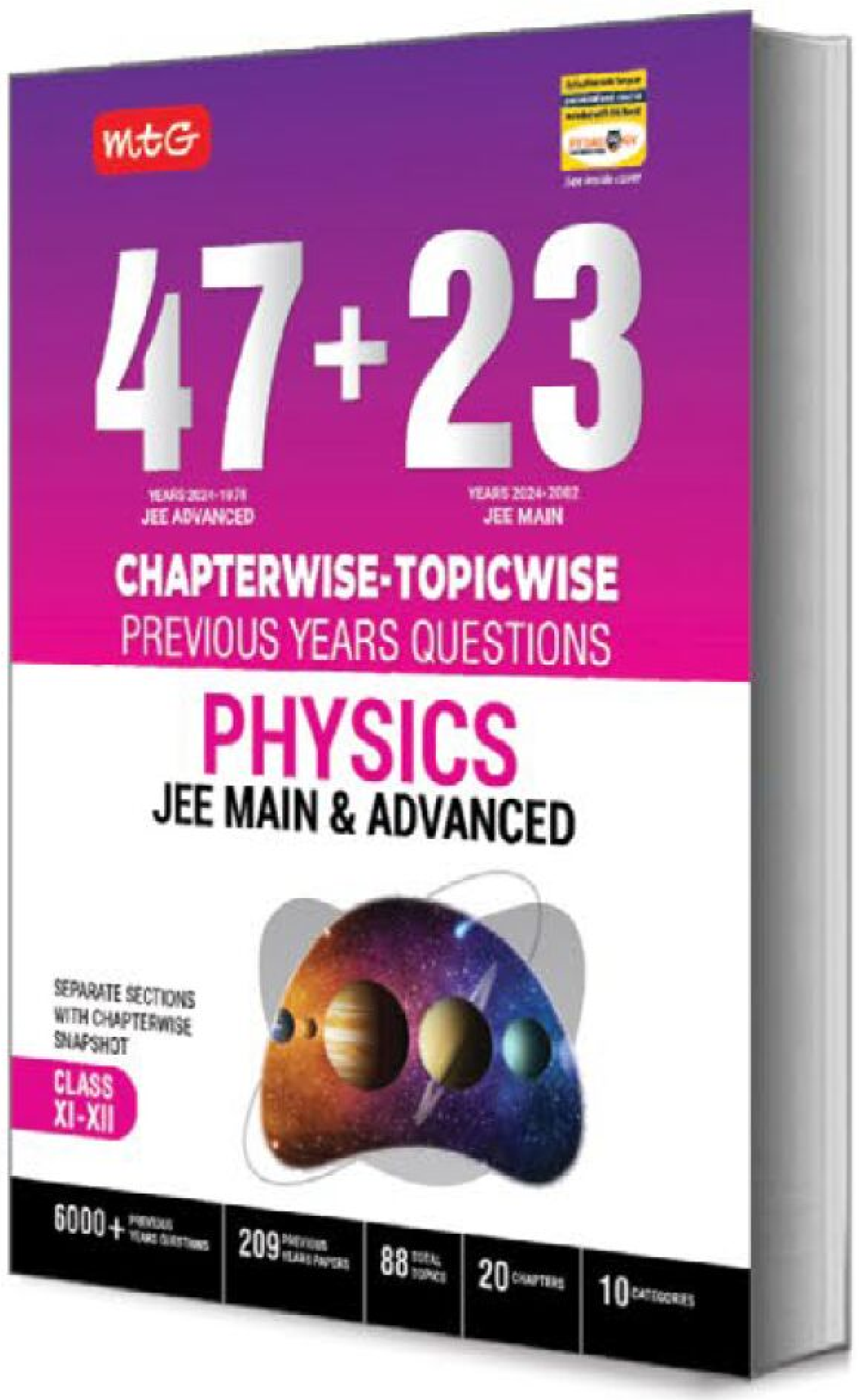
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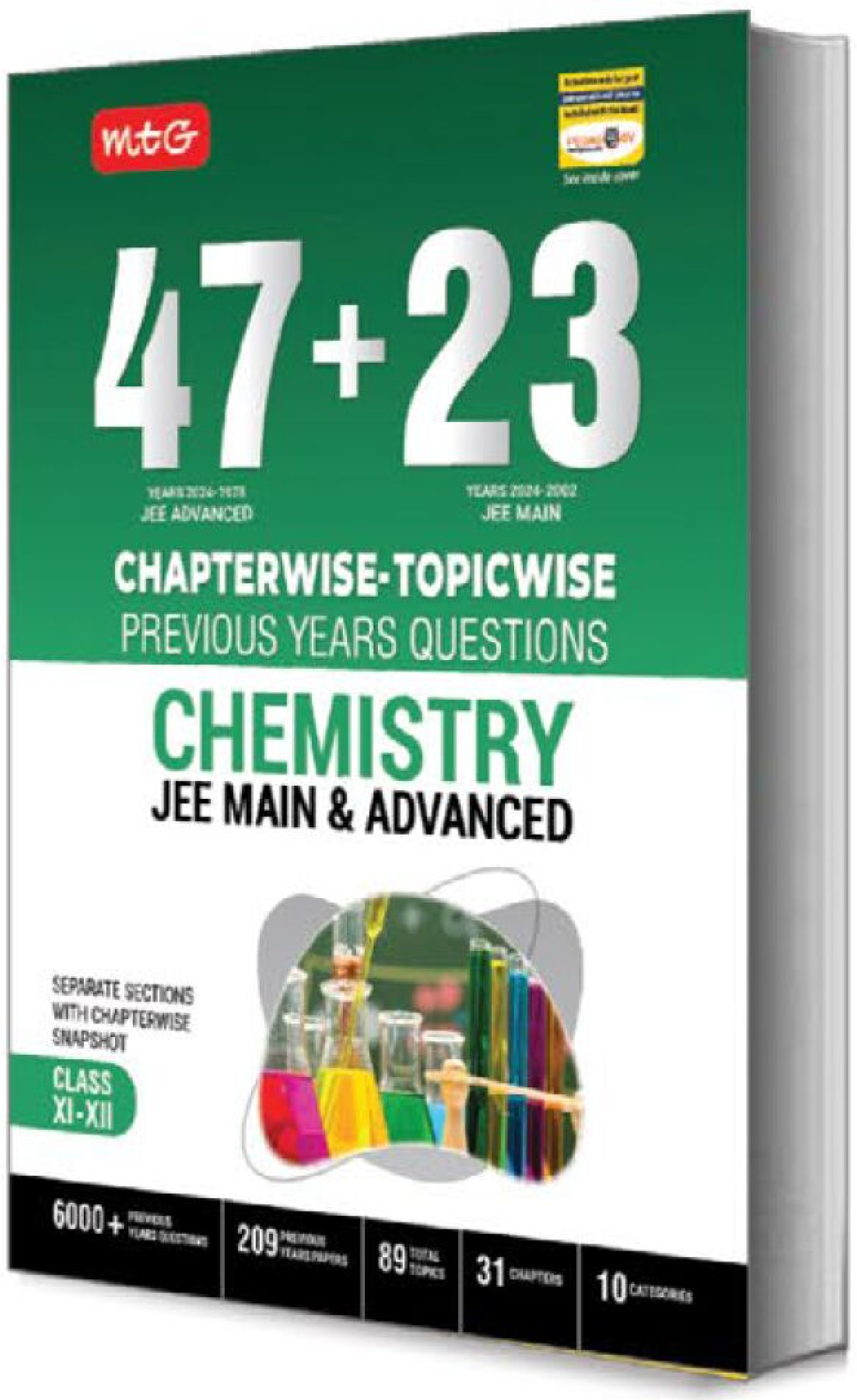
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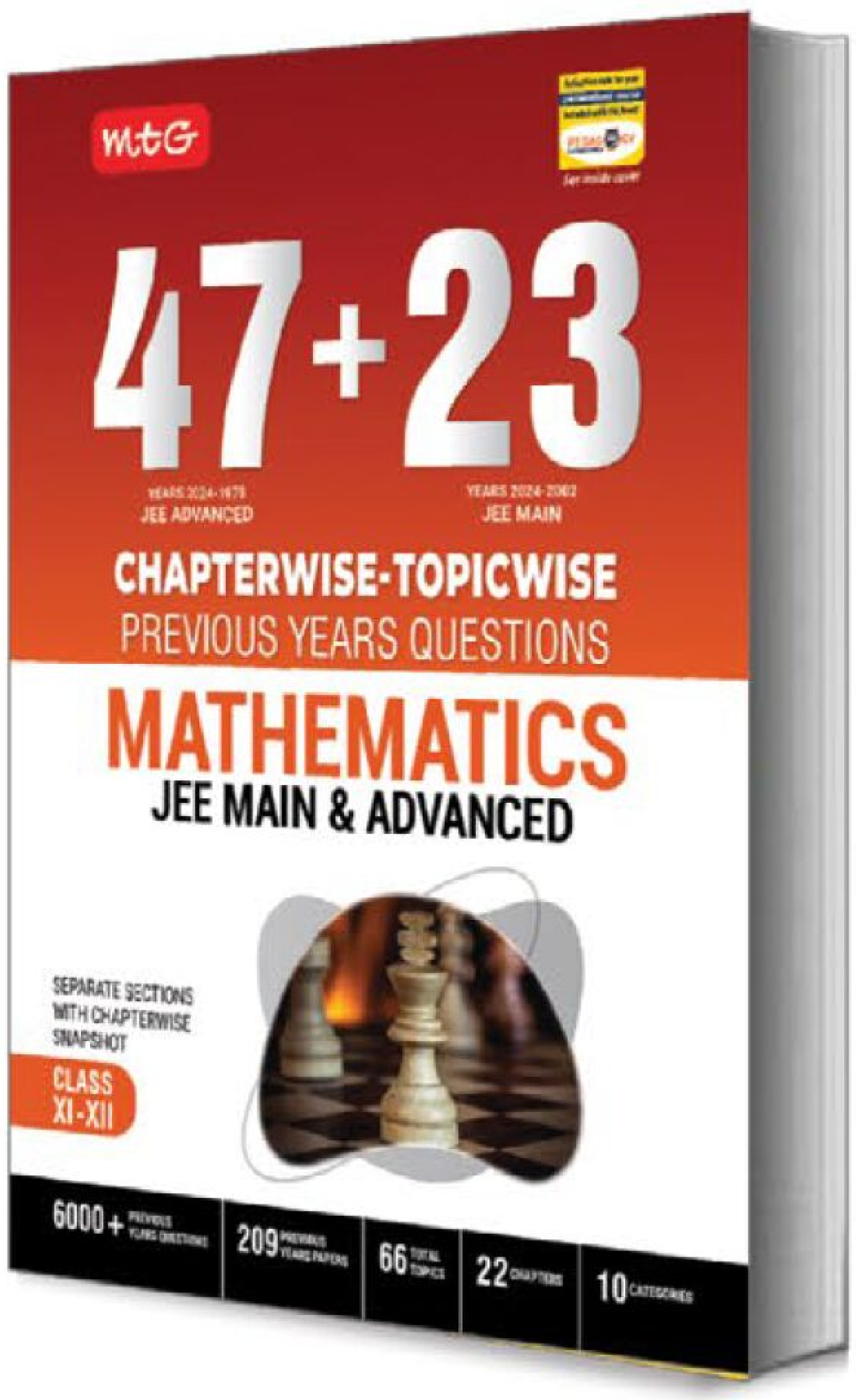
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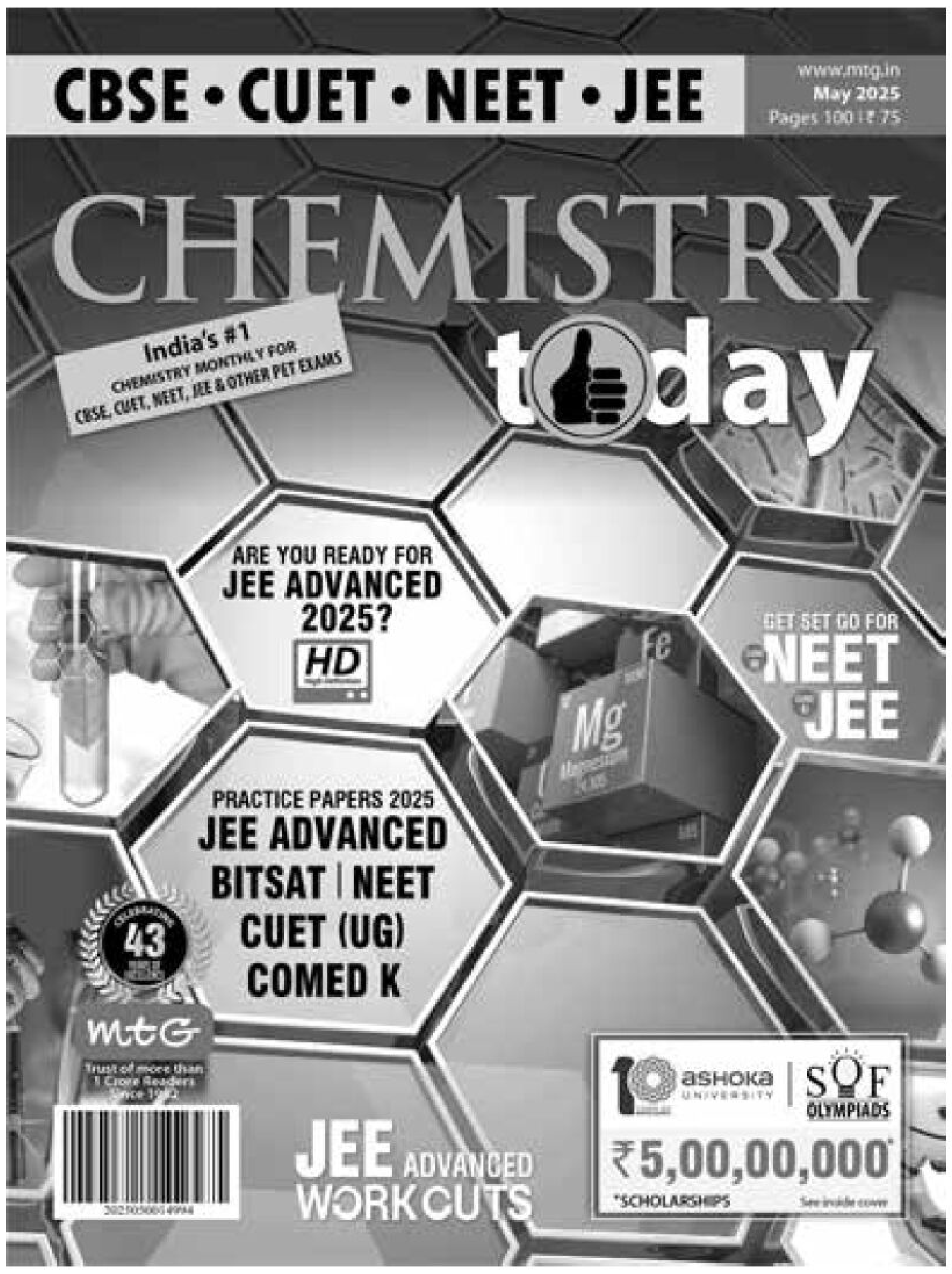
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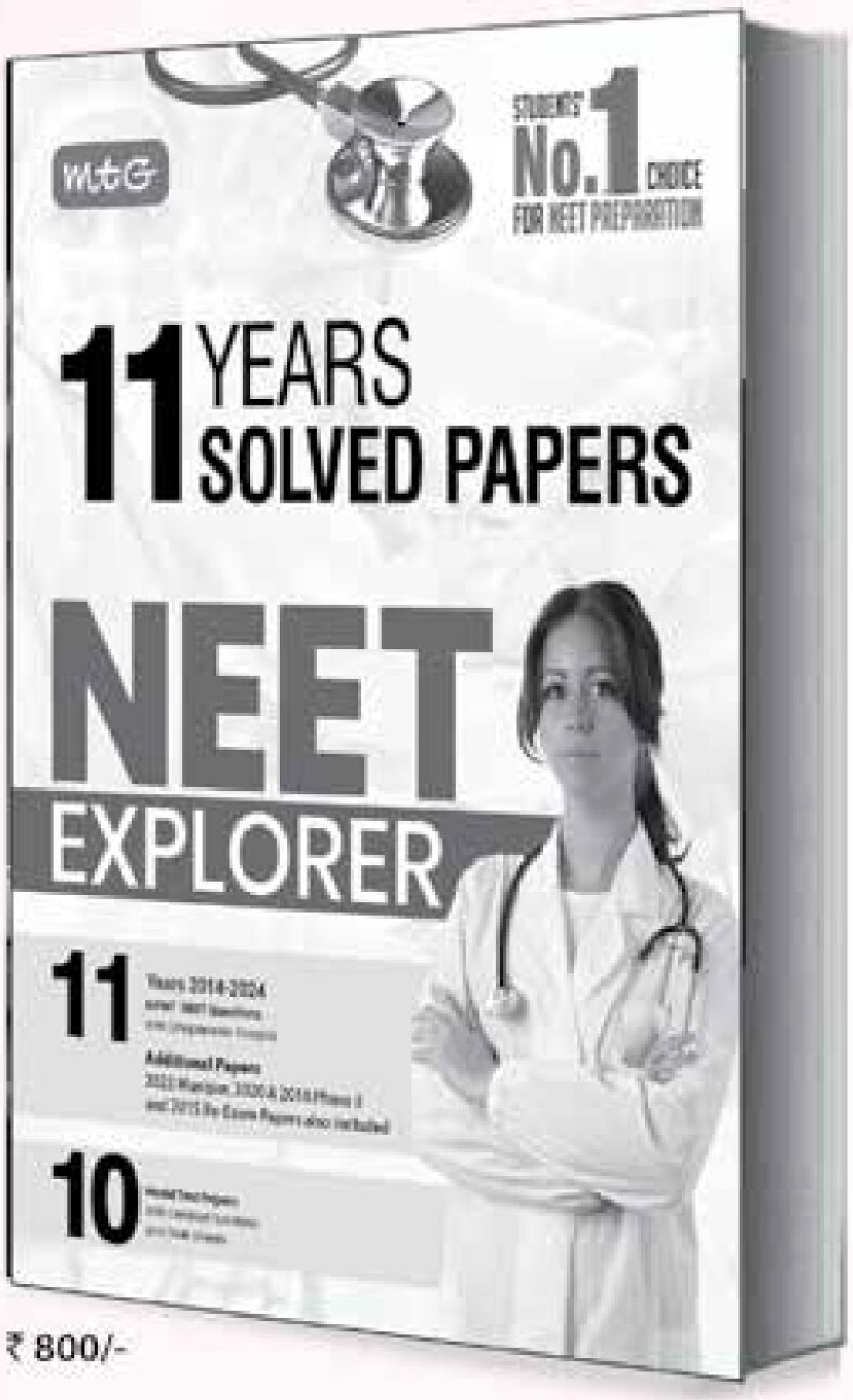

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Practice Paper

NEET

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1. Aniline is reacted with bromine water and the resulting product is treated with an aqueous solution of sodium nitrite in presence of dilute hydrochloric acid. The compound so formed is converted into a tetrafluoroborate which is subsequently heated to dry. The final product is
   (a) *p*-bromoaniline
   (b) *p*-bromofluorobenzene
   (c) 1, 3, 5-tribromobenzene
   (d) 2, 4, 6-tribromofluorobenzene.

2. The enthalpies of formation of Al_2O_3 and Cr_2O_3 are – 1596 kJ and – 1134 kJ respectively. ΔH for the reaction, $2Al + Cr_2O_3 \rightarrow 2Cr + Al_2O_3$ is
   (a) – 2730 kJ (b) – 462 kJ
   (c) – 1365 kJ (d) 2730 kJ

3. The molar conductance of 0.001 M acetic acid is 50 $ohm^{-1}\ cm^2\ mol^{-1}$. The maximum value of molar conductance is 250 $ohm^{-1}\ cm^2\ mol^{-1}$. What is its degree of ionization?
   (a) 0.5% (b) 2% (c) 20% (d) 22%

4. $(CH_3)_3CMgCl$ on reaction with D_2O produces
   (a) $(CH_3)_3CD$ (b) $(CH_3)_3COD$
   (c) $(CD_3)_3CD$ (d) $(CD_3)_3COD$

5. **Assertion :** If reaction is multiplied by a factor of 2 then its equilibrium constant becomes square of its initial value.
   Reason : The value of equilibrium constant is independent of initial concentrations of the reactants and product
   (a) If both assertion and reason are true and reason is the correct explanation of assertion.
   (b) If both assertion and reason are true but reason is not the correct explanation of assertion.
   (c) If assertion is true but reason is false.
   (d) If both assertion and reason are false.

6. The correct decreasing order of priority for the functional groups of organic compounds in the IUPAC system of nomenclature is
   (a) $–CONH_2 > –CHO > –SO_3H > –COOH$
   (b) $–COOH > –SO_3H > –CONH_2 > –CHO$
   (c) $–SO_3H > –COOH > –CONH_2 > –CHO$
   (d) $–CHO > –COOH > – SO_3H > –CONH_2$

7. The correct order of increasing boiling points is
   (a) *n*-butane < 1-butanol < *n*-butyl chloride < isobutane
   (b) *n*-butane < isobutane < *n*-butyl chloride < 1-butanol
   (c) isobutane < *n*-butyl chloride < *n*-butane < 1-butanol
   (d) isobutane < *n*-butane < *n*-butyl chloride < 1-butanol.

8. Based on equation $E = -2.178 \times 10^{-18}\ \text{J} \left(\frac{Z^2}{n^2}\right)$, certain conclusions are written. Which of them is not correct?
   (a) Equation can be used to calculate the change in energy when the electron changes orbit.
   (b) For $n = 1$, the electron has a more negative energy than it does for $n = 6$ which means that the electron is more loosely bound in the smallest allowed orbit.
   (c) The negative sign in equation simply means that the energy of electron bound to the nucleus is lower than it would be if the electrons were at the infinite distance from the nucleus.
   (d) Larger the value of *n*, the larger is the orbit radius.

9. **Statement-I :** $[Mn(CN)_6]^{3-}$, $[Fe(CN)_6]^{3-}$ and $[Co(C_2O_4)_3]^{3-}$ are d^2sp^3 hybridised.

Statement-II : $[MnCl_6]^{3-}$ and $[FeF_6]^{3-}$ are paramagnetic and have 4 and 5 unpaired electrons respectively.

(a) Both statement I and statement II are correct.
(b) Statement I is correct but statement II is incorrect.
(c) Both statement I and statement II are incorrect.
(d) Statement I is incorrect but statement II is correct.

10. Formaldehyde reacts with NaOH (50%). Which pair of products will be obtained?
(a) $CH_3COOH + CH_3OH$
(b) $CH_3OH + CH_3COONa$
(c) $CH_3COOH + C_2H_5OH$
(d) $HCOONa + CH_3OH$

11. The correct order of increasing oxidising power is
(a) $F_2 < Cl_2 < I_2 > Br_2$ (b) $F_2 < Br_2 < Cl_2 < I_2$
(c) $Cl_2 < Br_2 < F_2 < I_2$ (d) $I_2 < Br_2 < Cl_2 < F_2$

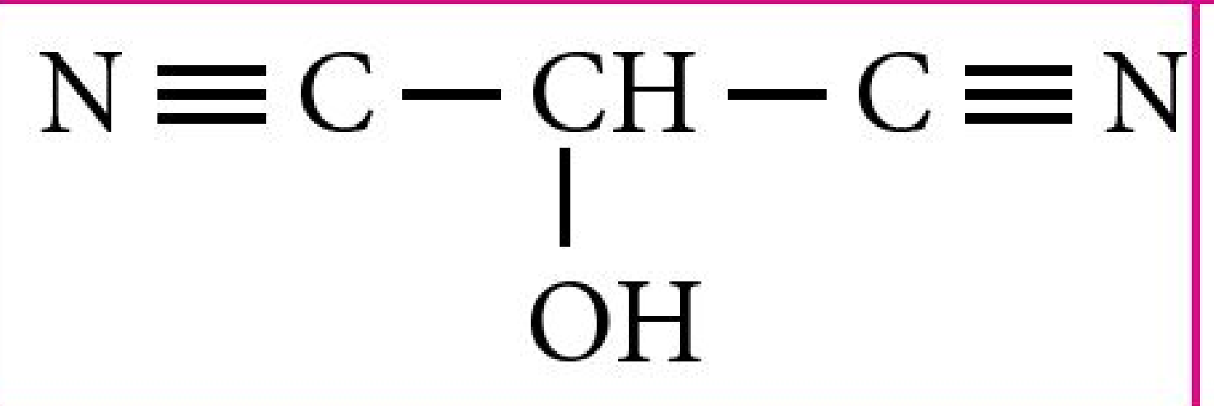
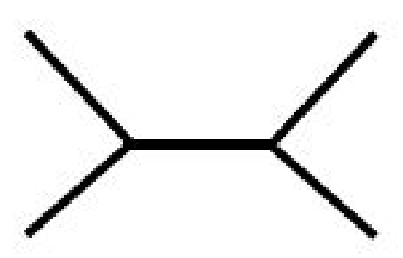
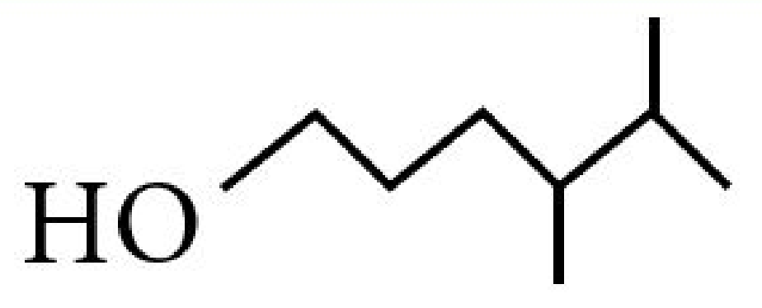
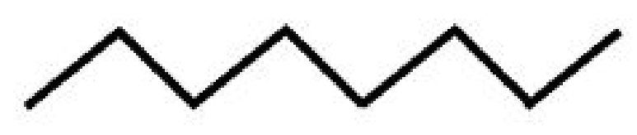
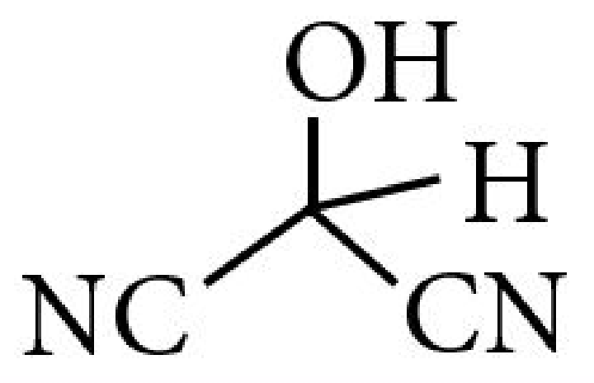
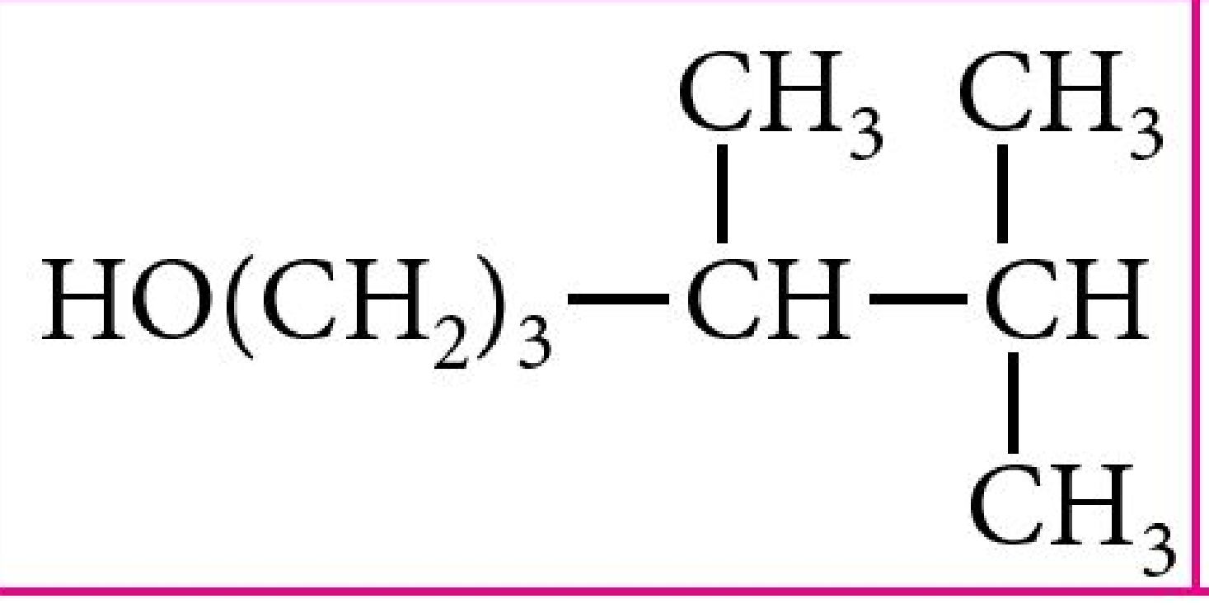
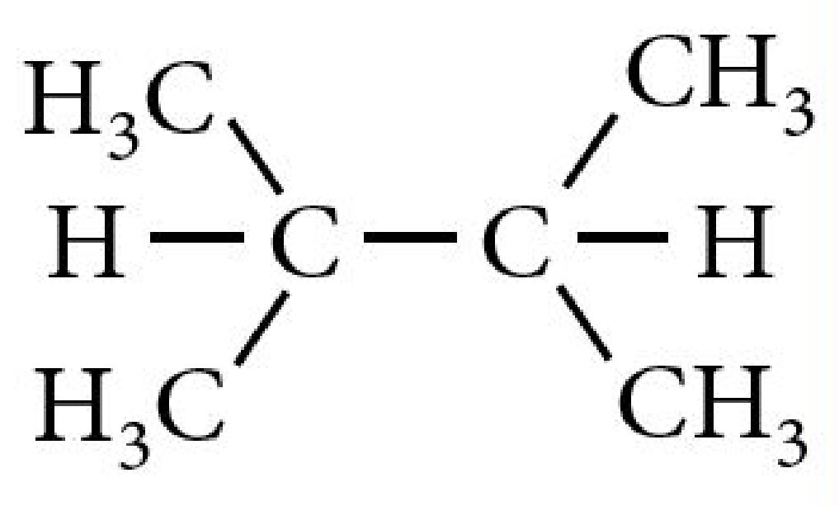
12. Number of atoms in 4.25 g of NH_3 is nearly
(a) 1×10^{23} (b) 1.5×10^{23}
(c) 2×10^{23} (d) 6×10^{23}

13. Which of the following species is paramagnetic?
(a) CO (b) CN^- (c) O_2^{2-} (d) NO

14. A diabetic person carries a packet of glucose with him always, because
(a) glucose increases the blood sugar level slowly
(b) glucose reduces the blood sugar level
(c) glucose increases the blood sugar level almost instantaneously
(d) glucose reduces the blood sugar level slowly.

15. Which of the following compound of xenon has zero dipole moment?
(a) XeO_2F_2 (b) XeF_3 (c) XeF_4 (d) XeF_6

16. Match the column-I with column-II and mark the appropriate choice.

Column-I		**Column-II**	
(A)	 $N\equiv C-\underset{\displaystyle OH}{\underset{\vert}{CH}}-C\equiv N$	(i)	$CH_3(CH_2)_6CH_3$
(B)		(ii)	
(C)		(iii)	
(D)	 $HO(CH_2)_3-\overset{\displaystyle CH_3}{\overset{\vert}{CH}}-\underset{\displaystyle CH_3}{\underset{\vert}{\overset{\displaystyle CH_3}{\overset{\vert}{CH}}}}$	(iv)	

(a) (A) → (iii), (B) → (iv), (C) → (i), (D) → (ii)
(b) (A) → (iv), (B) → (iii), (C) → (ii), (D) → (i)
(c) (A) → (i), (B) → (ii), (C) → (iv), (D) → (iii)
(d) (A) → (ii), (B) → (iii), (C) → (i), (D) → (iv)

17. The mass of a non-volatile solute of molar mass 40 g mol^{-1} that should be dissolved in 114 g of octane to lower its vapour pressure by 20% is
(a) 10 g (b) 11.4 g (c) 9.8 g (d) 12.8 g

18. The brown ring test for nitrates depends on
(a) the reduction of nitrate to nitric oxide
(b) oxidation of nitric oxide to nitrogen dioxide
(c) reduction of ferrous sulphate to iron
(d) oxidising action of sulphuric acid.

19. A nucleoside on hydrolysis gives
(a) a heterocyclic base and orthophosphoric acid
(b) an aldopentose, a heterocyclic base and orthophosphoric acid
(c) an aldopentose and a heterocyclic base
(d) an aldopentose and orthophosphoric acid.

20. CH_3CHO and $C_6H_5CH_2CHO$ can be distinguished chemically by
(a) Benedict's test (b) Iodoform test
(c) Tollens' reagent test (d) Fehling's solution test.

21. Which one of the following is the most acidic in nature?
(a) H_3CCOOH (b) Cl_3CCOOH
(c) Br_3CCOOH (d) F_3CCOOH

22. In which of the following, the order is not in accordance with the property mentioned.
(a) Li < Na < K < Rb – Atomic radius
(b) F > N > O > C – Ionisation enthalpy
(c) Si < P < S < Cl – Electronegativity
(d) F < Cl < Br < I – Electronegativity

23. The stability of Cu^{2+} is more than Cu^+ salts in aqueous solution due to
(a) hydration energy
(b) second ionisation enthalpy
(c) first ionisation enthalpy
(d) enthalpy of atomization.

24. Match the column-I with column-II and select the correct option.

Column-I		**Column-II**	
P.	Phthalein test	1.	Aldehydic group
Q.	Schiff's reagent test	2.	Amino group
R.	Nitrous acid test	3.	Alcoholic group
S.	Xanthate test	4.	Phenolic group

(a) (P) → 1, (Q) → 2, (R) → 3, (S) → 4
(b) (P) → 4, (Q) → 3, (R) → 2, (S) → 1

(c) (P) → 1, (Q) → 3, (R) → 2, (S) → 4
(d) (P) → 4, (Q) → 1, (R) → 2, (S) → 3

25. The volume of 0.1 M oxalic acid that can be completely oxidized by 20 mL of 0.025 M KMnO4 solution is
(a) 125 mL (b) 25 mL
(c) 12.5 mL (d) 37.5 mL

26. When *t*-butyl alcohol is heated with Cu at 573 K, it forms
(a) butanal (b) propanal
(c) ethyl methyl ketone (d) 2-methylprop-1-ene.

27. Which of the following is not true for S_N1 reaction?
(a) Favoured by polar solvents.
(b) 3°–alkyl halides generally react through S_N1 reaction.
(c) The rate of the reaction does not depend upon the molar concentration of the nucleophile.
(d) 1°–alkyl halides generally react through S_N1 reaction.

28. Half-life period of a first order reaction is 10 min. What percentage of the reaction will be completed in 100 min?
(a) 25% (b) 50% (c) 99.9% (d) 75%

29. Match the reaction in column-I with relation between ΔH and ΔU in column-II and select the correct option.

	Column-I		Column-II
A.	$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$	1.	$\Delta H = \Delta U + RT$
B.	$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$	2.	$\Delta H = \Delta U$
C.	$NH_4HS_{(s)} \rightarrow NH_{3(g)} + H_2S_{(g)}$	3.	$\Delta H = \Delta U - 2RT$
D.	$PCl_{5(g)} \rightarrow PCl_{3(g)} + Cl_{2(g)}$	4.	$\Delta H = \Delta U + 2RT$

(a) A → 4, B → 2, C → 3, D → 1
(b) A → 3, B → 2, C → 1, D → 4
(c) A → 1, B → 1, C → 2, D → 3
(d) A → 2, B → 3, C → 4, D → 1

30. **Assertion :** BF_3 is a weaker Lewis acid than BCl_3.
Reason : The $p\pi$-$p\pi$ back bonding is stronger in BF_3 than in BCl_3.
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

31. The value of the 'spin only' magnetic moment for one of the following configurations is 2.84 B.M. The correct one is
(a) d^4 (in strong ligand field)
(b) d^4 (in weak ligand field)
(c) d^3 (in weak as well as in strong fields)
(d) d^5 (in strong ligand field).

32. Which of the following statements concerning lanthanide elements is false?
(a) All lanthanides are highly dense metals.
(b) More characteristic oxidation state of lanthanide elements is +3.
(c) Lanthanides are separated from one another by ion exchange method.
(d) Ionic radii of trivalent lanthanides steadily increases with increase in the atomic number.

33. Four different sets of quantum numbers for four electrons are given below :

$$e_1 = 4, 0, 0, -\frac{1}{2}; e_2 = 3, 1, 1, -\frac{1}{2}$$

$$e_3 = 3, 2, 2, +\frac{1}{2}; e_4 = 3, 0, 0, +\frac{1}{2}$$

The order of energy of e_1, e_2, e_3 and e_4 is
(a) $e_1 > e_2 > e_3 > e_4$ (b) $e_4 > e_3 > e_2 > e_1$
(c) $e_3 > e_1 > e_2 > e_4$ (d) $e_2 > e_3 > e_4 > e_1$

34. In which one of the following molecules the central atom can be said to adopt sp^2 hybridization?
(a) BeF_2 (b) BF_3 (c) C_2H_2 (d) NH_3

35. Match the following and select the correct answer from the given codes.

	List-I		List-II
(A)	Potential of hydrogen electrode at pH = 10	(I)	0.76 V
(B)	$Cu^{2+} \mid Cu$	(II)	0.0591 V
(C)	$Zn \mid Zn^{2+}$	(III)	– 0.591 V
(D)	$\frac{2.303RT}{F}$	(IV)	0.0337 V

(a) A → III, B → I, C → IV, D → II
(b) A → III, B → I, C → II, D → IV
(c) A → III, B → II, C → I, D → IV
(d) A → III, B → IV, C → I, D → II

36. The highest electrical conductivity of the following aqueous solutions is of
(a) 0.1 M acetic acid
(b) 0.1 M chloroacetic acid
(c) 0.1 M fluoroacetic acid
(d) 0.1 M difluoroacetic acid.

37. In which of the following, entropy is increasing?

(a) Crystallisation of sugar from sugar solution

(b) $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

(c) $H_2 + I_2 \rightarrow 2HI$

(d) Adding naphthalene to benzene

38. If for a first order reaction, the values of A and E_a are 4×10^{13} sec^{-1} and 98.6 kJ/mol respectively, the at what temperature will its half-life period be 10 minutes?

(a) 330 K (b) 300 K

(c) 330.95 K (d) 311.15 K

39. Which of the following pairs are correctly matched?

	Reactants	**Products**
I.	$RX + AgOH_{(aq)}$	RH
II.	$RX + AgCN_{(alc)}$	RNC
III.	$RX + KCN_{(alc)}$	RNC
IV.	$RX + Na_{(ether)}$	$R—R$

(a) I alone (b) I and II

(c) II and III (d) II and IV

40. Osmotic pressure of the solution can be increased by

(a) increasing the temperature of the solution

(b) decreasing the temperature of the solution

(c) increasing the volume of the vessel

(d) diluting the solution.

41. Choose the compound which can react with $[Ag(NH_3)_2]^+$ and on treatment with alkaline $KMnO_4$ gives $(CH_3)_3C — COOH$

(a) $CH_3CH_2CH_2C{\equiv}C—CH_3$

(b) $(CH_3)_2CHCH_2C{\equiv}CH$

(c) $(CH_3)_3C—C{\equiv}CH$

(d) $(CH_3)_3C—C{\equiv}C—CH_3$

42. According to Le-Chatelier's principle, the equilibrium constant of a reversible reaction will not shift by

(a) increasing the temperature of an exothermic reaction

(b) increasing the temperature of an endothermic reaction

(c) changing the concentrations of the reactants.

(d) the effect of a catalyst.

43. Indicate which nitrogen compound amongst the following would undergo Hoffmann reaction (*i.e.*, reaction with Br_2 and strong KOH) to furnish the primary amine (R–NH_2)?

(a) $RCONHCH_3$ (b) $RCOONH_4$

(c) $RCONH_2$ (d) $R - CO - NHOH$

44. In which of the following cases a chemical reaction is possible?

(a) $AgNO_3$ solution is stirred with a copper spoon.

(b) Conc. HNO_3 is stored in a platinum vessel.

(c) Gold ornaments are washed with dil. HCl.

(d) $ZnSO_{4(aq)}$ is placed in a copper vessel.

45. **Statement I :** Increasing order of metallic character is : P < Si < Be < Mg < Na

Statement II : Metallic character increases along a period and decreases down a group.

(a) Both statement I and statement II are correct.

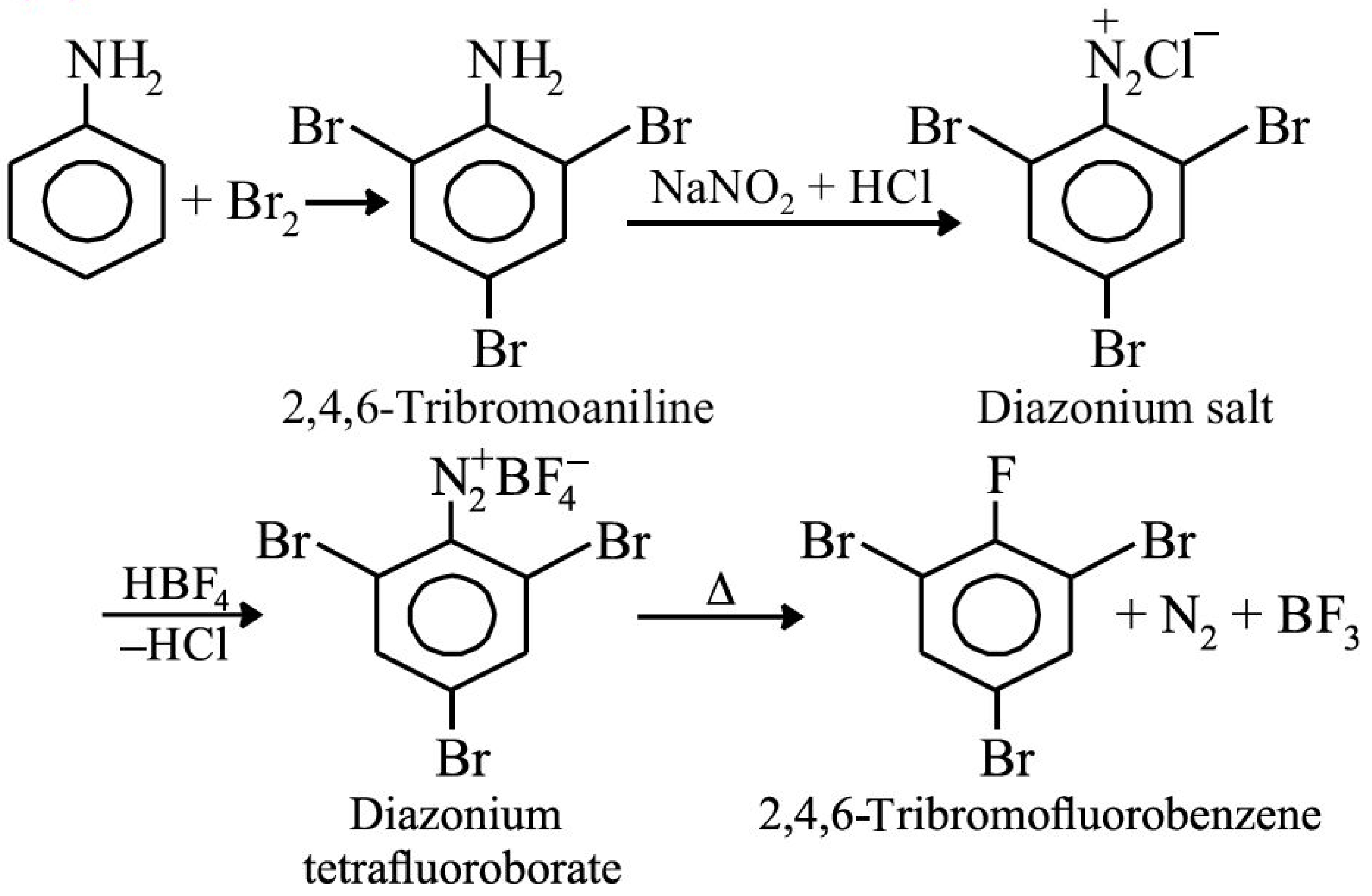
(b) Both statement I and statement II are incorrect.

(c) Statement I is correct but statement II is incorrect.

(d) Statement I is incorrect but statement II is correct.

SOLUTIONS

1. **(d) :**



2. **(b) :** Given:

$2\ Al + 3/2O_2 \rightarrow Al_2O_3;\ \Delta H = -\ 1596\ kJ$ ...(i)

$2\ Cr + 3/2O_2 \rightarrow Cr_2O_3;\ \Delta H = -\ 1134\ kJ$ ...(ii)

Subtract (ii) from (i)

$2Al - 2\ Cr \rightarrow Al_2O_3 - Cr_2O_3;\ \Delta H = -\ 462\ kJ$

or $2Al + Cr_2O_3 \rightarrow Al_2O_3 + 2\ Cr;\ \Delta H = -462\ kJ$

3. **(c) :** $\alpha = \dfrac{\Lambda_c}{\Lambda_0} = \dfrac{50}{250} \Rightarrow \alpha = 0.2 \times 100 = 20\%$

4. **(a) :** $(CH_3)_3CMgCl + D_2O \rightarrow (CH_3)_3CD + Mg(OD)Cl$

5. **(b)** **6.** **(b)**

7. **(d) :** Increase in branching decreases surface area of the molecule and therefore, results in lesser van der Waals' forces. Consequently, isobutane has lesser boiling point than n-butane.

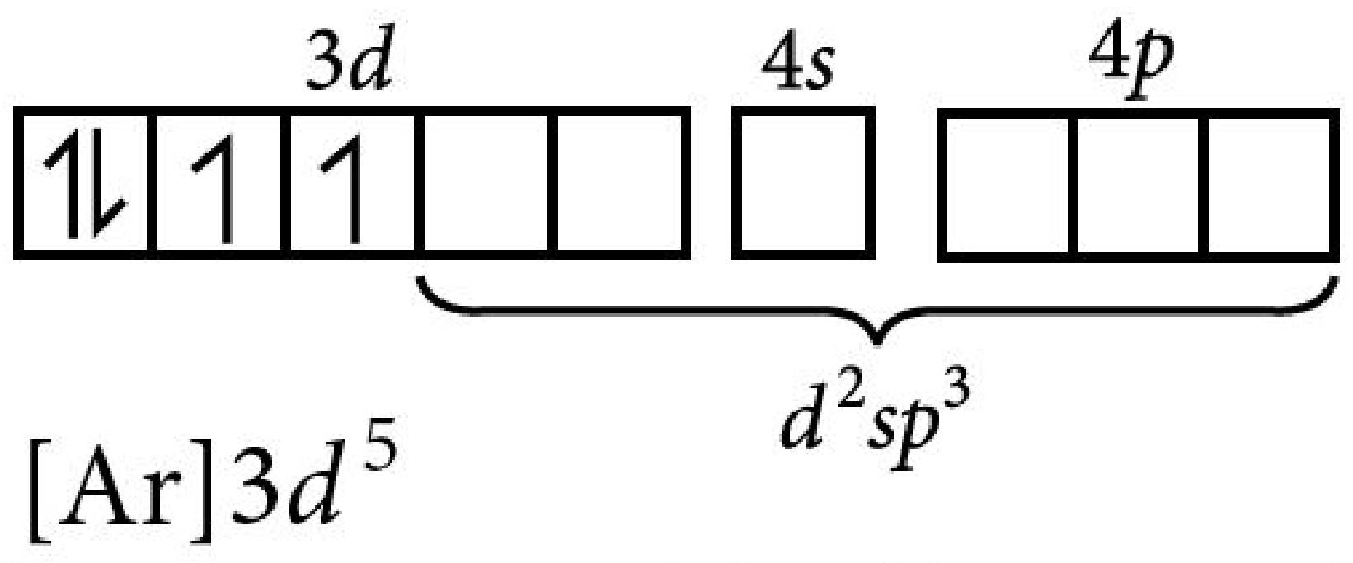
Alkyl chlorides have higher boiling points than corresponding alkanes, because they are polar and stronger dipole-dipole forces operate between the molecules of alkyl chlorides.

Alcohols have higher boiling points than corresponding alkyl chlorides, because alcohol molecules are associated through strong H-bonds.

8. **(b) :** The electron is more tightly bound in the smallest allowed orbit

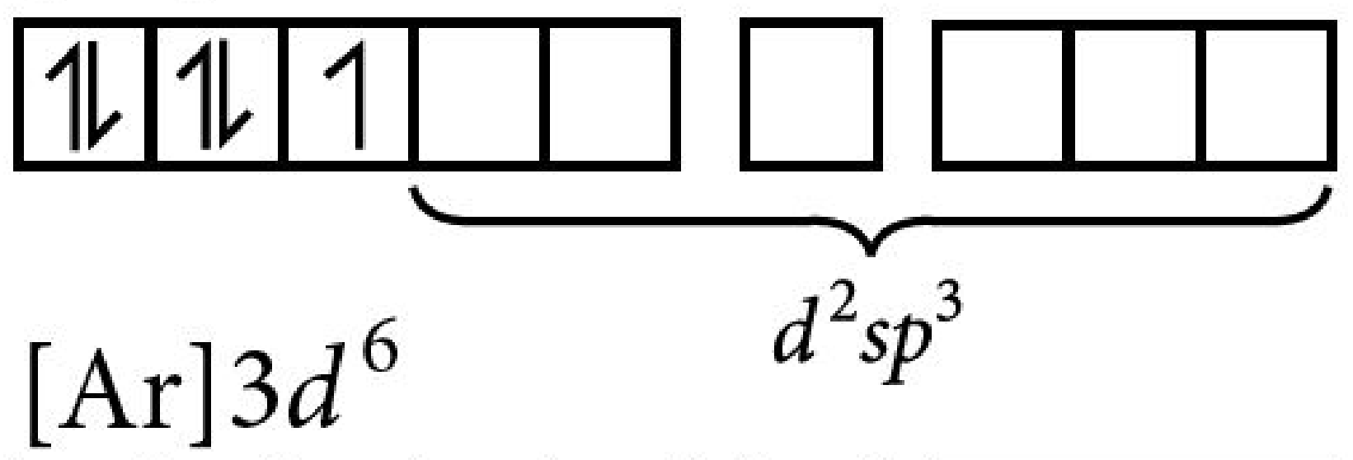
9. **(a) :** Mn^{3+} : $[Ar]3d^4$

$[Mn(CN)_6]^{3-}$:



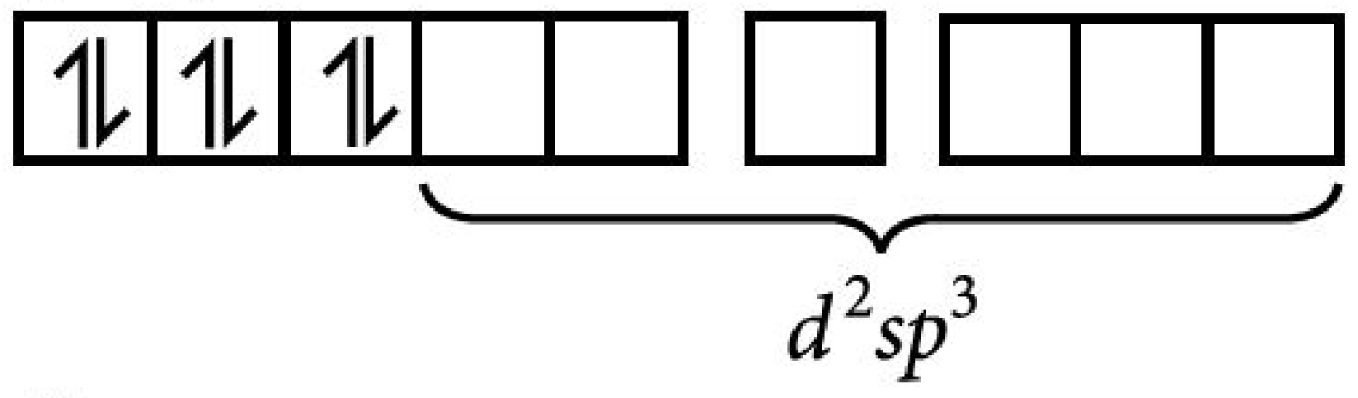
Fe^{3+} : $[Ar]3d^5$

$[Fe(CN)_6]^{3-}$:



Co^{3+} : $[Ar]3d^6$

$[Co(C_2O_4)_3]^{3-}$:



As CN^- and $C_2O_4^{2-}$ are strong field ligands so pairing of electrons takes place and inner orbital complexes are formed. While in case of $[MnCl_6]^{3-}$ and $[FeF_6]^{3-}$, due to the presence of weak field ligands, pairing does not take place and these complexes have 4 and 5 unpaired electrons respectively.

10. (d): $2HCHO + NaOH \longrightarrow HCOONa + CH_3OH$

11. (d): Standard reduction potentials of halogens are positive and decreases from fluorine to iodine. Thus halogens act as strong oxidising agents and their oxidising power decreases from fluorine to iodine.

Element	F	Cl	Br	I
Reduction potential (in V)	+2.87	+1.36	+1.06	+0.54

$\xrightarrow{\text{oxidising power decreases}}$

12. (d): Number of molecules in 4.25 g NH_3

$$= N_A \times \text{number of moles} = N_A \times \frac{4.25}{17} = \frac{N_A}{4}$$

1 molecule contains 4 atoms (1 nitrogen and 3 hydrogen)

So, total number of atoms present

$$= 4 \times \frac{N_A}{4} = 6.022 \times 10^{23}$$

13. (d): As per their molecular orbital electronic configurations CO, CN^- and O_2^{2-} are diamagnetic and NO is paramagnetic.

14. (c): The sugar level in the blood of a diabetic person may suddenly fall, immediate intake of glucose increases the blood sugar level almost instantaneously.

15. (c): In XeF_4, the four fluorine atoms are present at the corners of a square plane and two lone pairs are present at axial positions. All the individual bond moments in such an arrangement cancel out, as a result, the molecule has zero dipole moment.

16. (a)

17. (a): According to Raoult's law,

$$\frac{p^\circ - p_s}{p^\circ} = \frac{w_A/m_A}{\frac{w_A}{m_A} + \frac{w_B}{m_B}}$$

where, w_A, $m_A \longrightarrow$ weight dissolved and molecular mass of solute respectively.

w_B, $m_B \longrightarrow$ weight dissolved and molecular mass of solvent respectively.

$p^\circ \longrightarrow$ vapour pressure of pure solvent

$p_s \longrightarrow$ vapour pressure of solution.

$$\frac{p^\circ - p_s}{p^\circ} = \frac{20}{100} = 0.2$$

$$0.2 = \frac{\frac{w_A}{40}}{\frac{w_A}{40} + \frac{114}{114}} \Rightarrow \frac{w_A/40}{\frac{w_A + 40}{40}} \Rightarrow 0.2 = \frac{w_A}{w_A + 40}$$

$0.2\ w_A + 8 = w_A$

$8 = w_A - 0.2\ w_A = 0.8\ w_A$ or $w_A = 10$ g

18. (a): The brown ring is appeared due to the formation of a brown complex between nitric oxide (formed as a result of reduction of the nitrate ion by the Fe^{2+} ions) and Fe^{2+} ions.

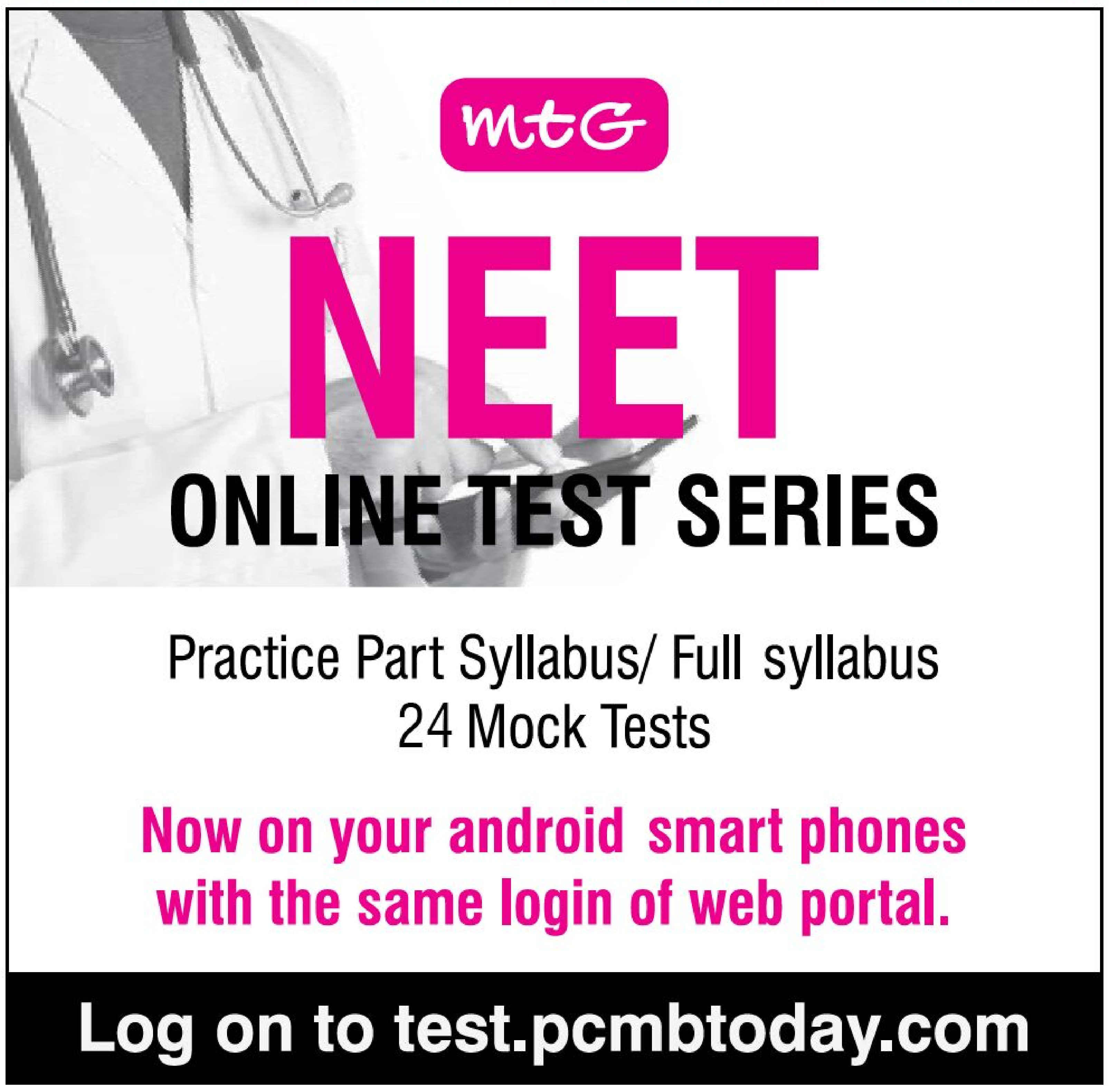
$$NO_3^-{}_{(aq)} + 3Fe^{2+}{}_{(aq)} + 4H^+{}_{(aq)} \rightarrow NO_{(g)} + 3Fe^{3+}{}_{(aq)} + 2H_2O_{(l)}$$

$$Fe^{2+}{}_{(aq)} + NO_{(g)} + 5H_2O_{(l)} \rightarrow [Fe(H_2O)_5NO^+]^{2+}{}_{(aq)}$$

Pentaaquanitrosonium iron (I)
(Brown complex)

19. (c): A molecule called nucleoside is formed by condensing a molecule of the heterocyclic base with the appropriate pentose sugar (*i.e.* base + sugar).

20. (b): Acetaldehyde, acetone and methyl ketones having CH_3CO- group undergo haloform reaction. Thus, CH_3CHO will give yellow precipitate with I_2 and NaOH but $C_6H_5CH_2CHO$ will not give yellow precipitate.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21. (d): Fluorine has the highest electronegativity because of which it creates strong electron withdrawing effect which stabilises the conjugate base and increases the acidity of carboxylic acid.

22. (d): Electronegativity decreases down the group.

23. (a): The stability of $Cu^{2+}_{(aq)}$ rather than $Cu^{+}_{(aq)}$ is due to the much more negative $\Delta_{hyd}H^\circ$ of $Cu^{2+}_{(aq)}$ than $Cu^{+}_{(aq)}$, which more than compensates for the second ionisation enthalpy of Cu.

V_2O_4 dissolves in acids to give VO^{2+} salts.

24. (d): Phthalein test is for phenolic group. Schiff reagent test is for aldehydic group. Nitrous acid test is used to identify amine. Xanthate test is for alcoholic group.

25. (c) : $2KMnO_4 + 5(COOH)_2 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 10CO_2 + 8H_2O$

2 moles of $KMnO_4 \equiv$ 5 moles of $(COOH)_2$

$\therefore$ $20 \times 0.025 \times 10-3$ moles of $KMnO_4$

$$\equiv \frac{5}{2} \times 20 \times 0.025 \times 10^{-3}$$

$= 1.25 \times 10^{-3}$ moles of $(COOH)_2$

0.1 mole of oxalic acid are present in 1000 mL

$\therefore$ 1.25×10^{-3} mole will be present in

$$= \frac{1000}{0.1} \times 1.25 \times 10^{-3} = 12.5 \text{ mL}$$

26. (d): $(CH_3)_3COH \xrightarrow[\text{dehydration}]{\text{Cu, 573 K}} (CH_3)_2C = CH_2 + H_2O$

27. (d): S_N1 reaction is favoured by bulky groups on the carbon atom attached to halogens; *i.e.*, the order of reactivity is

$$\underset{\text{Tertiary}}{R_3C - X} > \underset{\text{Secondary}}{R_2CH - X} > \underset{\text{Primary}}{RCH_2 - X} > \underset{\text{Methyl}}{CH_3 - X}$$

28. (c) : $\dfrac{0.693}{t_{1/2}} = \dfrac{2.303}{t}\log\dfrac{a}{a-x}$

$$\frac{0.693}{10} = \frac{2.303}{100}\log\frac{100}{100-x} \Rightarrow x = 99.9$$

29. (d): For reaction $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$

$\Delta H = \Delta U + \Delta n_g RT$

$\Delta n_g = 1 - 1 = 0$

$\Delta H = \Delta U$

$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

$\Delta H = \Delta U + \Delta n_g RT$

$\Delta n_g = 2 - 4 = -2$

$\Delta H = \Delta U - 2RT$

$NH_4HS_{(s)} \rightarrow NH_{3(g)} + H_2S_{(g)}$

$\Delta n_g = 2 - 0 = 2$

$\Delta H = \Delta U + 2RT$

$PCl_{5(g)} \rightarrow PCl_{3(g)} + Cl_{2(g)}$

$\Delta H = \Delta U + \Delta n_g RT$

$\Delta n_g = 2 - 1 = 1$

$\Delta H = \Delta U + RT$

30. (a)

31. (a): In an octahedral complex, for a d^4 configuration in a strong field ligand, number of unpaired electrons = 2

Spin only magnetic moment $= \sqrt{n(n+2)}$ B.M.

Where n = no. of unpaired electron.

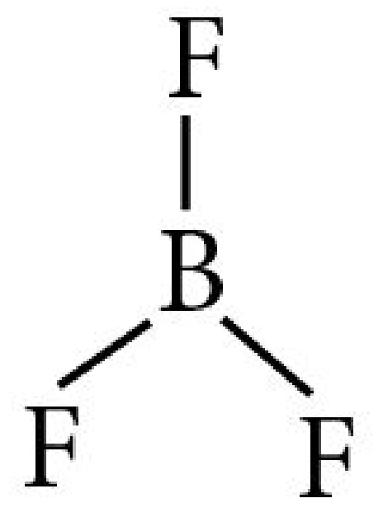
Given, $\sqrt{n(n+2)} = 2.84 \Rightarrow n = 2$

32. (d): Ionic radii of trivalent lanthanides decreases with increase in atomic number.

33. (c) : Higher $(n + l)$ value, higher is the energy and for same $(n + l)$ value higher n, higher will be the energy.

Thus, $e_3 > e_1 > e_2 > e_4$

34. (b): BF_3 involves sp^2-hybridisation.



35. (d): (A) pH = 10 $\therefore$ $[H^+] = 1 \times 10^{-10}$ M

$$\therefore E = E^\circ - \frac{0.0591}{n}\log\frac{1}{[H^+]} = 0 - \frac{0.0591}{1}\log\frac{1}{10^{-10}}$$

$= -0.0591 \times \log 10^{10} = -0.0591 \times 10 = -0.591$ V

(B) $Cu^{2+} | Cu$, $E^\circ_{Red} = +0.337$ V

(C) $Zn^{2+} | Zn$ $E^\circ_{Red} = -0.76$ V

(D) $\dfrac{2.303RT}{F} = 0.0591$ V

36. (d): Higher the acidity, higher will be the tendency to release protons and hence higher will be the electrical conductivity. Difluoroacetic acid will be strongest acid due to electron withdrawing effect of two fluorine atoms so as it will show maximum electrical conductivity.

37. (d): Entropy is defined as the quantity which measures the disorderness of a system. It increaseccs when disorderness increases.

38. (d): According to Arrhenius equation, $k = Ae^{-E_a/RT}$

$$\log k = \log A - \frac{E_a}{2.303RT} \quad \text{... (1)}$$

For a first order reaction, $t_{1/2} = \dfrac{0.693}{k}$

$t_{1/2}$ = 10 min = 600 s

$$\therefore\ k = \frac{0.693}{600} = 1.1\times10^{-3}\ \text{s}^{-1} \qquad \text{... (2)}$$

Putting value of k from eq. (2) in eq. (1) we get,

$$\log(1.1\times10^{-3}) = \log(4\times10^{13}) - \frac{98.6\times10^{3}}{2.303\times8.314\times T}$$

$\therefore\quad T = 311.15$ K

39. (d): $R-X + AgCN_{(alc)} \rightarrow RNC + AgX$
$2R-X + 2Na \rightarrow R-R + 2NaX$

40. (a): $\pi = CRT = \frac{n}{V}RT\ ;\ \pi \propto T$

41. (c) : Since the compound reacts with $[Ag(NH_3)_2]^+$, the compound must be a terminal alkyne with group $\equiv$ CH.On treatment with alkaline $KMnO_4$ compound gives $(CH_3)_3C—COOH$ which shows the presence of $(CH_3)_3C—C\equiv C$ group. Thus, the compound should be $(CH_3)_3C—C\equiv CH$.

$$(CH_3)_3C-C\equiv CH \xrightarrow[\text{[O]}]{KMnO_4} (CH_3)_3C-COOH + HCOOH$$

42. (d): A catalyst does not alter the state of equilibrium. It increases the rate of forward as well as backward reaction to the same extent. The only effect is that equilibrium is attained quickly.

43. (c) : The amide $(-CONH_2)$ group is converted into primary amino group $(-NH_2)$ by Hoffmann's bromamide degradation reaction.

$$RCONH_2 + Br_2 + 4KOH \xrightarrow{\Delta} \underset{1°\text{amine}}{R-NH_2} + 2KBr + K_2CO_3 + 2H_2O$$

44. (a) : When $AgNO_3$ solution is stirred with a copper spoon, displacement reaction will take place *i.e.*, Cu displace Ag from $AgNO_3$ solution

$$Cu + 2AgNO_3 \longrightarrow Cu(NO_3)_2 + 2Ag$$

45. (c) : The elements can be arranged in different periods and groups as follows :

Period/Group	1	2	13	14	15
2nd	–	Be	–	–	–
3rd	Na	Mg	–	Si	P

As metallic character decreases along a period and increases down a group, so Na is the most metallic element than Mg and Si and P is the least metallic element. Among Be and Mg, Mg is more metallic. Hence, increasing order of metallic character is :
P < Si < Be < Mg < Na

◆◆

UNSCRAMBLE ME

Unscramble the words given in column I and match them with their explanations in column II.

	Column I		Column II
1.	NROOEUTISL	(a)	It is the process of introduction of hydroxyl group into an organic compound.
2.	RRUANMECTIO	(b)	It is the colourless crystals with molecular formula $C_6H_8O_4$, prepared by slow distillation of concentrated solutions of lactic acids.
3.	SANEUBER	(c)	The formation of Hg (II) derivatives of aromatic compounds by direct substitution.
4.	NTIOYHORDXYLA	(d)	They are the phospholipids analogous to lecithins and cephalins. Occur in brain and muscle.
5.	TELATRIF	(e)	It is the separation of a racemate into its two enantiomorphic forms.
6.	SNEGPSALMALO	(f)	It is the trivial name for cycloheptane .
7.	AETLYMPOH	(g)	It is a strongly acidic group containing $CF_3SO_3^-$ group.
8.	ACTIDEL	(h)	It is the enzyme present in yeast which converts glucose to ethanol but can also induce other reactions.
9.	ALANGESSCI	(i)	It is an amphoteric electrolyte ,which can behave as both an acid and a base.
10.	YEAMSZ	(j)	They are the compounds which can reduce pain perceptions.

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month. Winners' names and answers will be published in next issue.

JEE 2025 PRACTICE PAPER ADVANCED

Exam on 18th May

PAPER-I

SECTION 1 (MAXIMUM MARKS : 12)

- *This section contains FOUR (04) questions.*
- *Each question has FOUR options (a), (b), (c) and (d). ONLY ONE of these four options is the correct answer.*
- *For each question, choose the option corresponding to the correct answer.*
- *Answer to each question will be evaluated according to the following marking scheme:*

Full Marks : +3 If ONLY the correct option is chosen;
Zero Marks : 0 If none of the options is chosen (i.e., the question is unanswered);
Negative Marks : –1 In all other cases.

1. In the reaction, $2SO_2 + O_2 \rightleftharpoons 2SO_3$, starting with 2 moles of SO_2 and 1 mole of O_2 in 1 L flask, mixture required 0.4 moles of MnO_4^- in acidic medium. Hence, K_c is

(a) 2.0 (b) 0.4 (c) 1.6 (d) 2.6

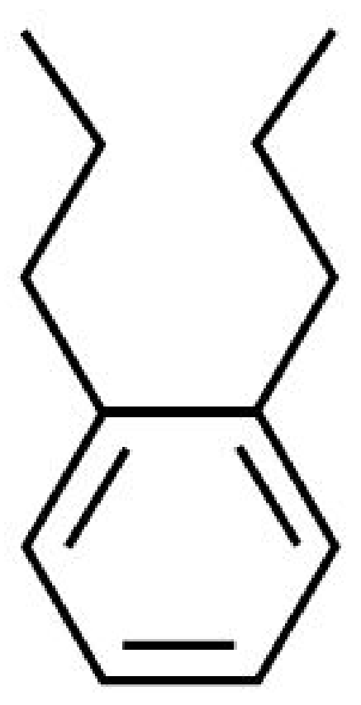
2. Reduction of but-2-yne with Na and liquid NH_3 gives an alkene which upon catalytic hydrogenation with D_2/Pt gives an alkane. The alkene and alkane formed respectively are

(a) *Cis*-but-2-ene and *racemic*-2, 3-dideuterobutane
(b) *Trans*-but-2-ene and *meso*-2, 3-dideuterobutane
(c) *Trans*-but-2-ene and *racemic*-2, 3-dideuterobutane
(d) *Cis*-but-2-ene and *meso*-2, 3-dideuterobutane.

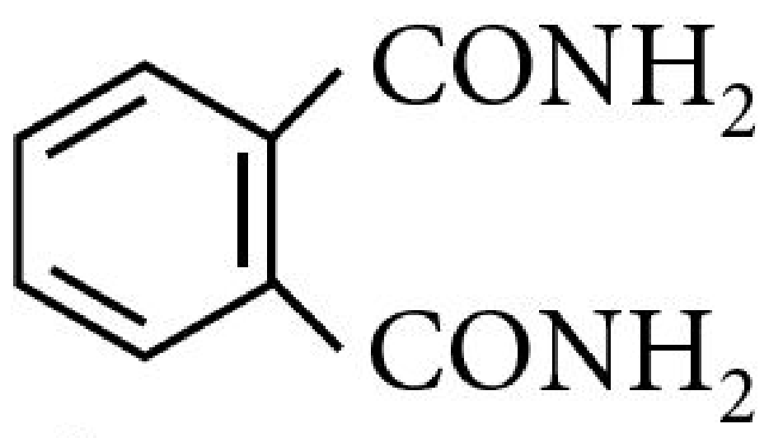
3. If the unit cell of a mineral has cubic close packed (ccp) array of oxygen atoms with m fraction of octahedral holes occupied by aluminium ions and n fraction of tetrahedral holes occupied by magnesium ions, m and n, respectively, are

(a) $\frac{1}{2}, \frac{1}{8}$ (b) $1, \frac{1}{4}$
(c) $\frac{1}{2}, \frac{1}{2}$ (d) $\frac{1}{4}, \frac{1}{8}$

4. Treatment of compound O with $KMnO_4/H^+$ gave P, which on heating with ammonia gave Q. The compound Q on treatment with Br_2/NaOH produced R. On strong heating, Q gave S, which on further treatment with ethyl-2-bromopropanoate in the presence of KOH followed by acidification, gave a compound T.



(O)

(a) The compound R is 

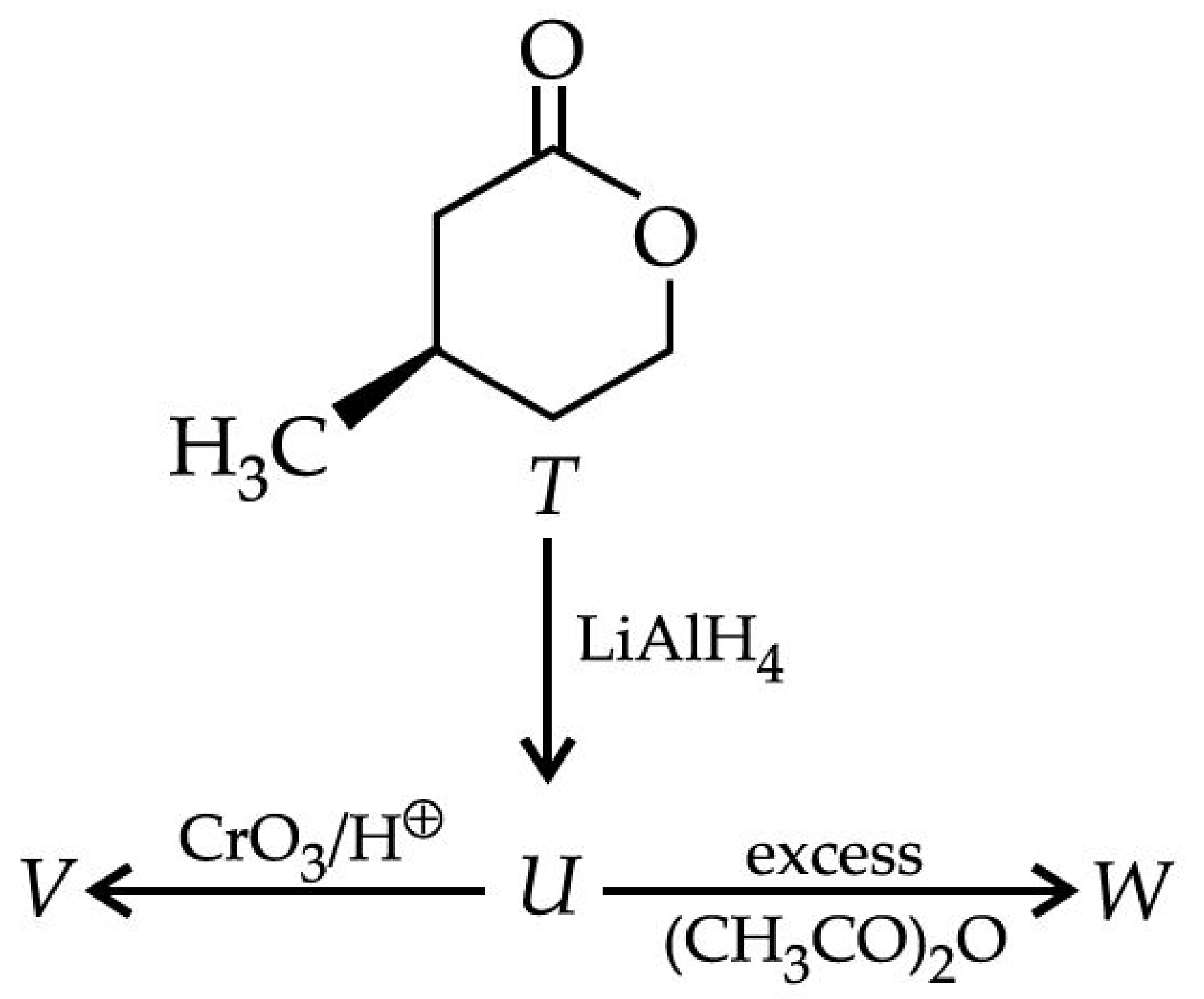
(b) The compound T is alanine
(c) The compounds P and R are phthalic acid and phthalimide respectively.
(d) The compounds S and Q are -phenylenediamine and serine respectively.

SECTION 2 (MAXIMUM MARKS : 12)

- *This section contains THREE (03) questions.*
- *Each question has FOUR options (a), (b), (c) and (d). ONE OR MORE THAN ONE of these four option(s) is(are) correct answer(s).*
- *For each question, choose the option(s) corresponding to (all) the correct answer(s).*
- *Answer to each question will be evaluated according to the following marking scheme:*

Full Marks : +4 ONLY if (all) the correct option(s) is(are) chosen;
Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;
Partial Marks : +2 If three or more options are correct but ONLY two options are chosen, both of which are correct;
Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks : 0 If none of the options is chosen (i.e., the question is unanswered);
Negative Marks : –2 In all other cases.

5. With reference to the scheme given, which of the given statement(s) about T, U, V and W is (are) correct?



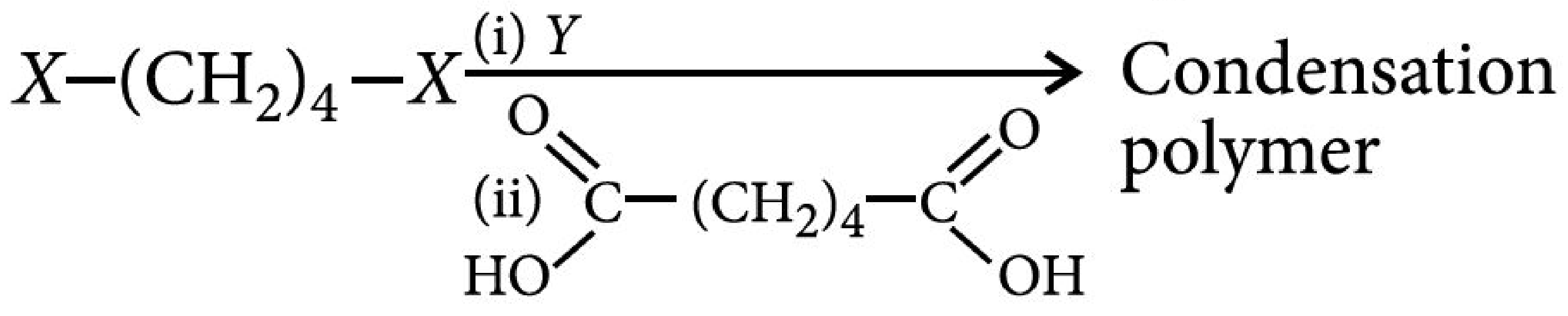
(a) T is soluble in hot aqueous NaOH.

(b) U is optically active.

(c) Molecular formula of W is $C_{10}H_{18}O_4$.

(d) V gives effervescence on treatment with aqueous $NaHCO_3$

6. The correct functional group X and the reagent/reaction conditions Y in the following scheme are



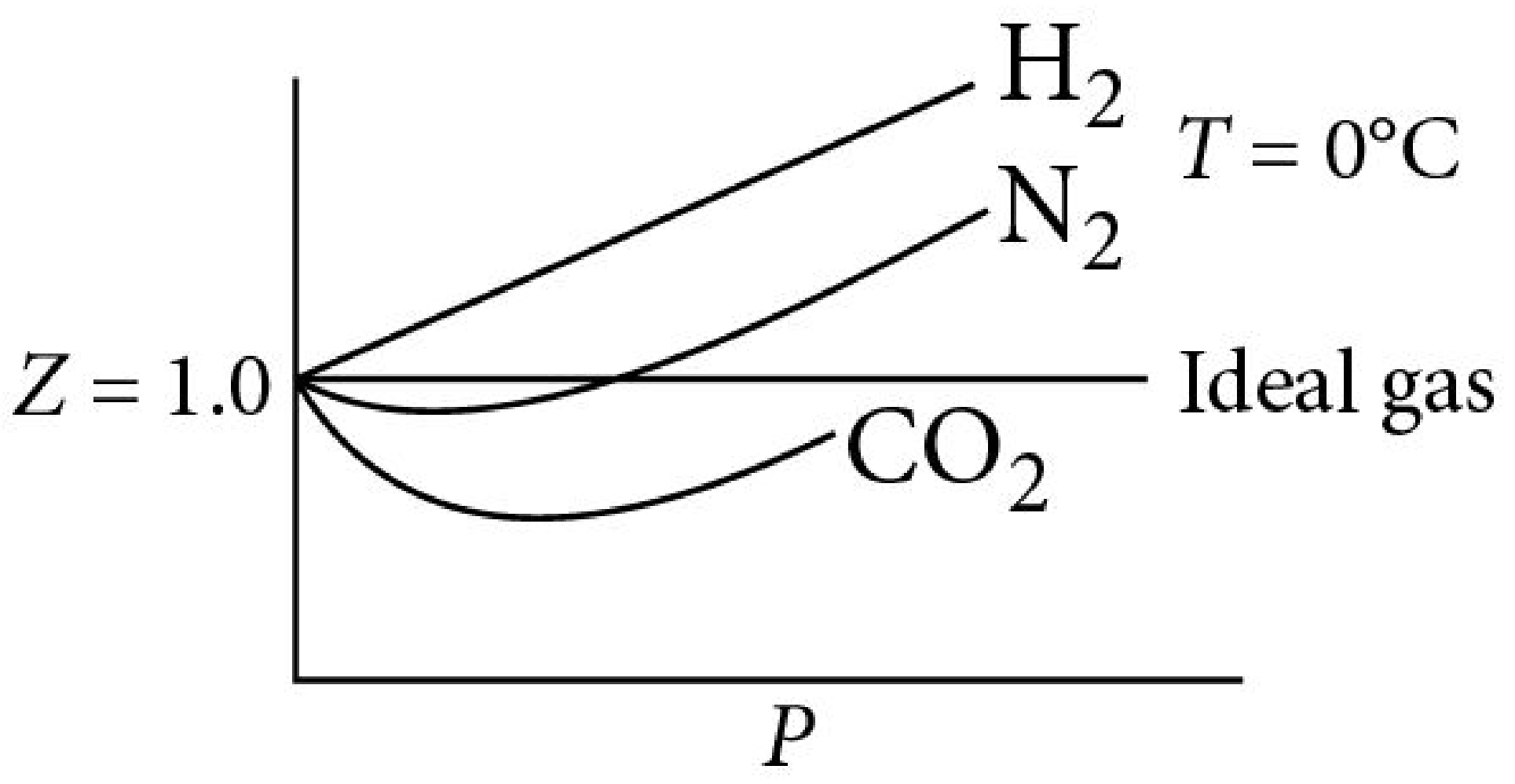
(a) $X = COOCH_3$, $Y = H_2/Ni/heat$

(b) $X = CONH_2$, $Y = H_2/Ni/heat$

(c) $X = CONH_2$, $Y = Br_2/NaOH$

(d) $X = CN$, $Y = H_2/Ni/heat$.

7. Which of the following is/are correct statement(s) for compressibility factor?



(a) Z is always greater than 1 for H_2.

(b) For N_2, $Z < 1$ in the lower pressure region and $Z > 1$ in the higher pressure region. The curve has a minimum at particular pressure.

(c) In CO_2, Z dips sharply below the ideal line in the lower pressure region.

(d) Gases for which $Z > 1$ show positive deviation from ideal behaviour and for which $Z < 1$, shows negative deviation from ideal behaviour.

SECTION 3 (MAXIMUM MARKS : 24)

- *This section contains SIX (06) questions.*
- *The answer to each question is a NON-NEGATIVE INTEGER.*
- *Answer to each question will be evaluated according to the following marking scheme:*

Full Marks : +4 If ONLY the correct integer is entered;

Zero Marks : 0 In all other cases.

8. Not considering the electronic spin, the degeneracy of the second excited state ($n = 3$) of H atom is 9, while the degeneracy of the second excited state of H^- is ________.

9. Among the complex ions, $[Co(NH_2CH_2CH_2NH_2)_2Cl_2]^+$, $[CrCl_2(C_2O_4)_2]^{3-}$, $[Fe(H_2O)_4(OH)_2]^+$, $[Fe(NH_3)_2(CN)_4]^-$, $[Co(NH_2CH_2CH_2NH_2)_2(NH_3)Cl]^{2+}$ and $[Co(NH_3)_4(H_2O)Cl]^{2+}$, the number of complex ion(s) that show(s) geometrical-isomerism is ________.

10. The molar conductivity of a solution of a weak acid HX (0.01 M) is 10 times smaller than the molar conductivity of a solution of a weak acid HY (0.10 M). If $\lambda^\circ_{X^-} \approx \lambda^\circ_{Y^-}$, the difference in their pK_a values, $pK_a(HX) - pK_a(HY)$, is (consider degree of ionization of both acids to be << 1) ________.

11. 0.2 M $NaNO_3$ and 0.1 M $Ca(NO_3)_2$ solutions are mixed in the ratio of $x : y$ such that in the resulting solution, the concentration of anions is 50% greater than that of cations. The value of $x + y$ is ________.

12. A hydrogenation reaction is carried out at 500 K. If same reaction is carried out in the presence of a catalyst at the same rate, the temperature required is 400 K. The activation energy of the reaction if the catalyst lowers the activation barrier by 20 kJ mol^{-1} is ________.

13. (X) is prepared by dissolving ammonium chloride and disodium hydrogen phosphate in molecular proportion in hot water. When heated, X melts to form a clear transparent mass having the property of combining with metallic oxides to form coloured orthophosphates. The number of water molecules present in (X) is ________.

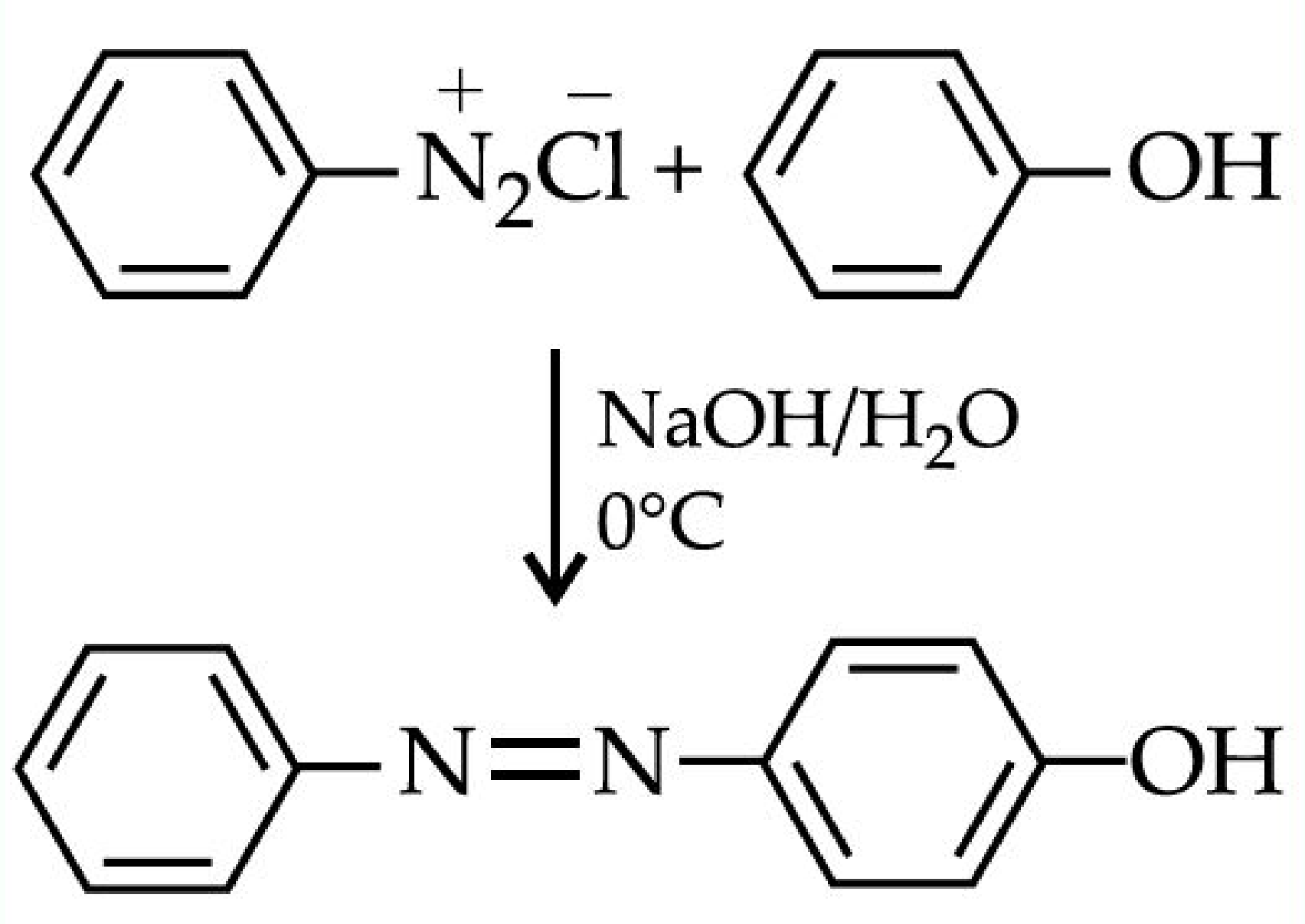
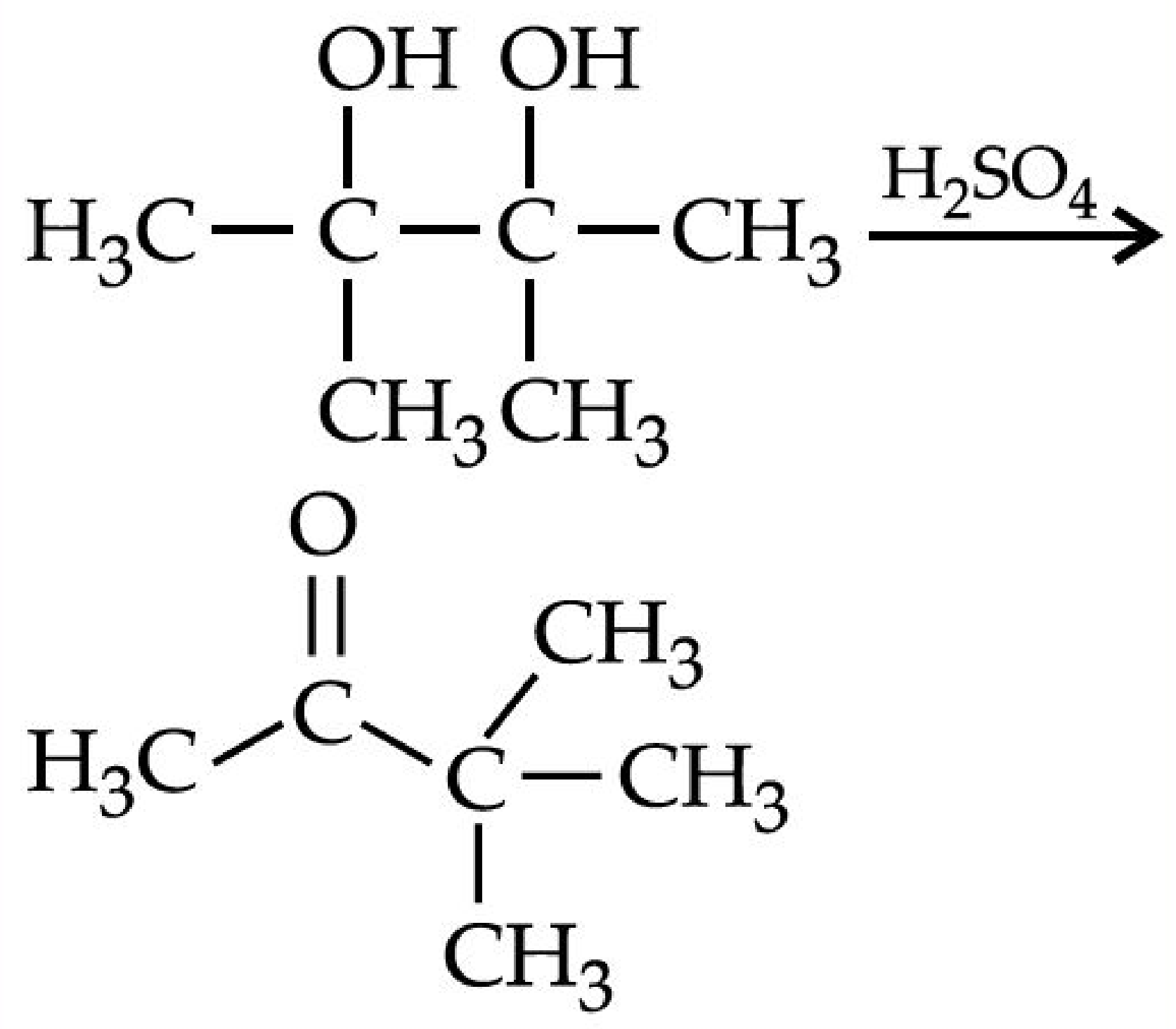
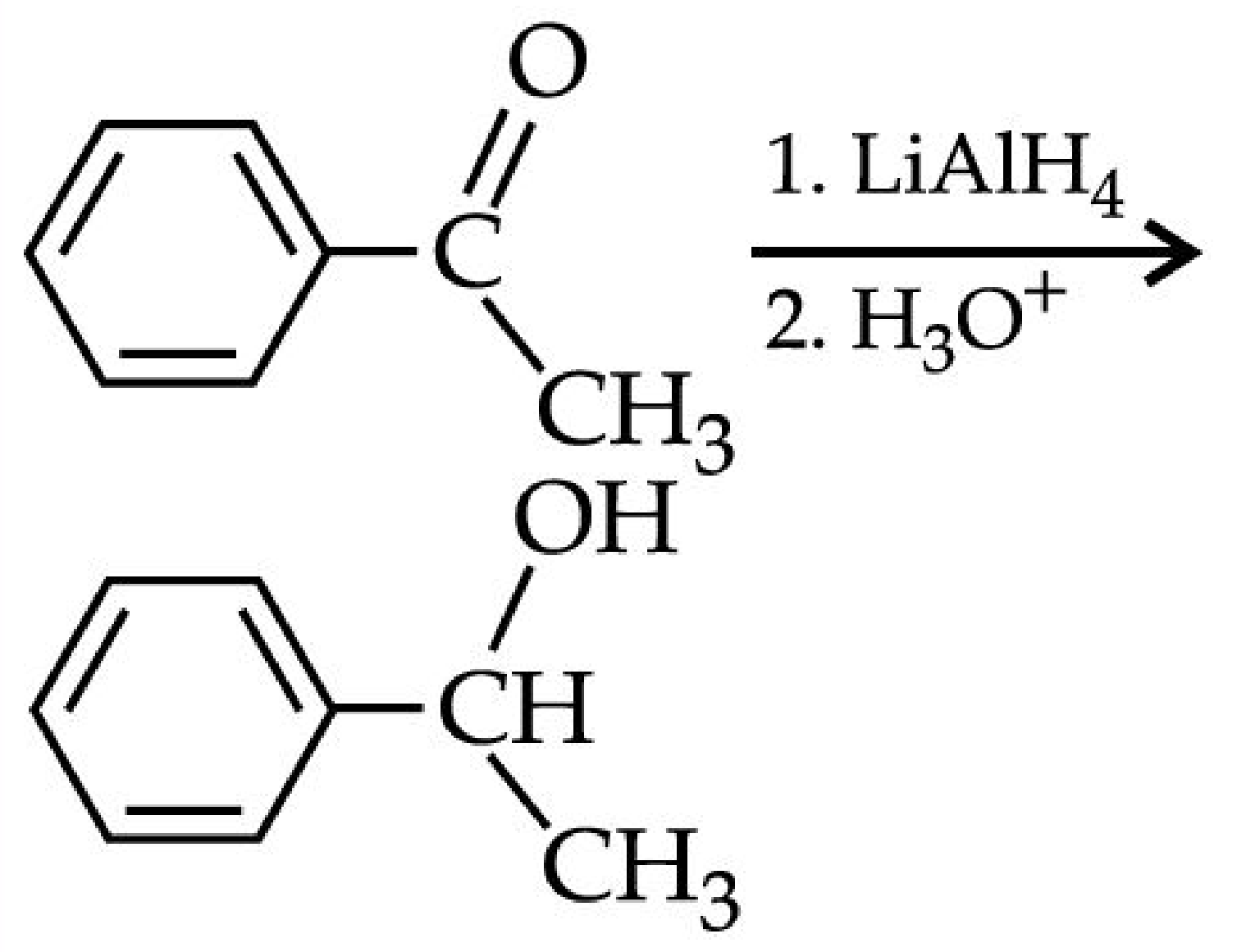
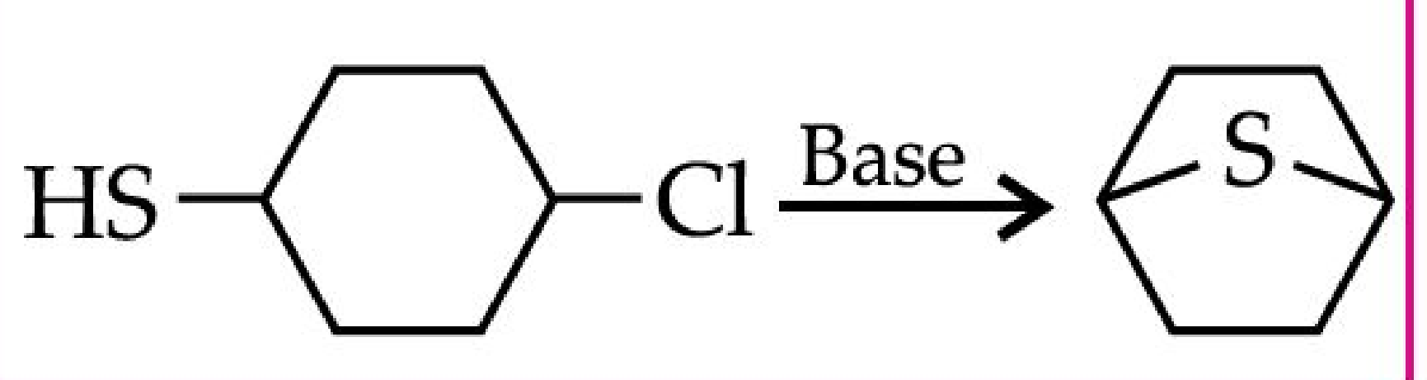
SECTION 4 (MAXIMUM MARKS : 12)

- *This section contains FOUR (04) Matching List Sets.*
- *Each set has ONE Multiple Choice Question.*
- *Eact set has TWO lists : List-I and List-II.*
- *List-I has Four entries (P), (Q), (R) and (S) and List-II has Five entries (1), (2), (3), (4) and (5).*
- *FOUR options are given in each Multiple Choice Question based on List-I and List-II and ONLY ONE of these four options satisfies the condition asked in the Multiple Choice Question.*
- *Answer to each question will be evaluated according to the following marking scheme:*

Full Marks : +3 ONLY if the option corresponding to the correct combination is chosen;

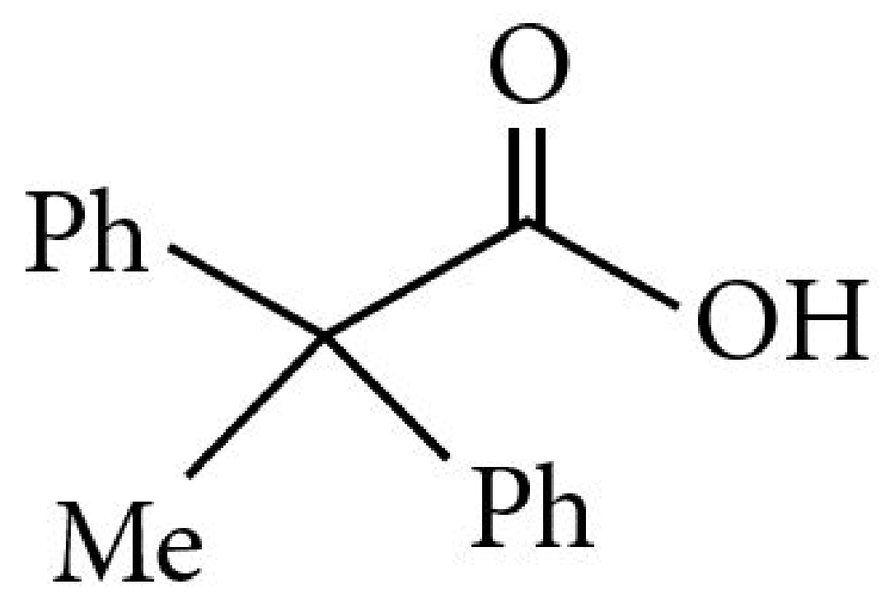
Zero Marks : 0 *If none of the options is chosen (i.e. the question is unanswered);*
Negative Marks : –1 *In all other cases.*

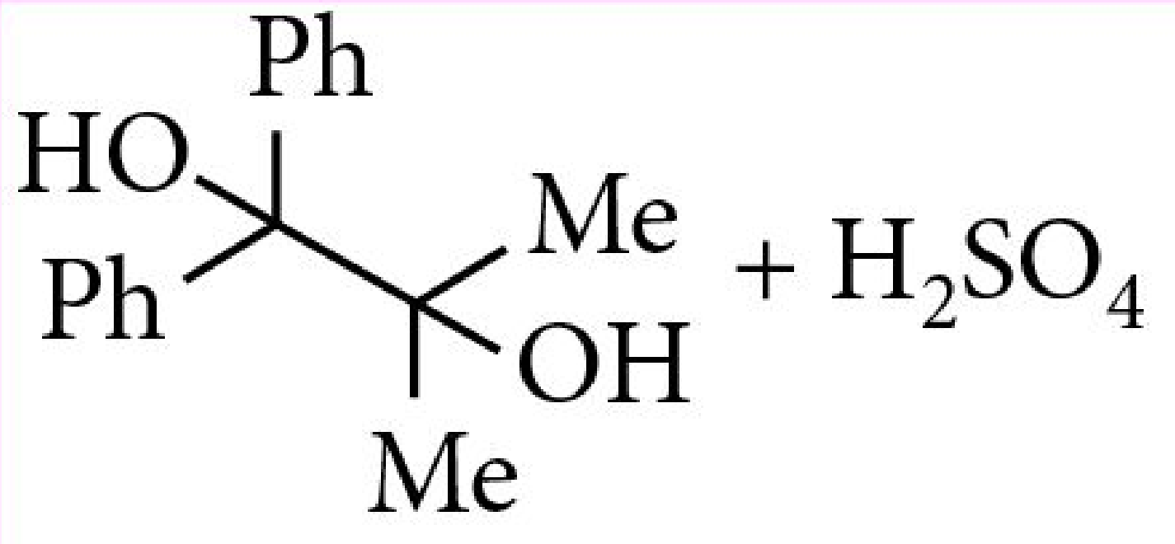
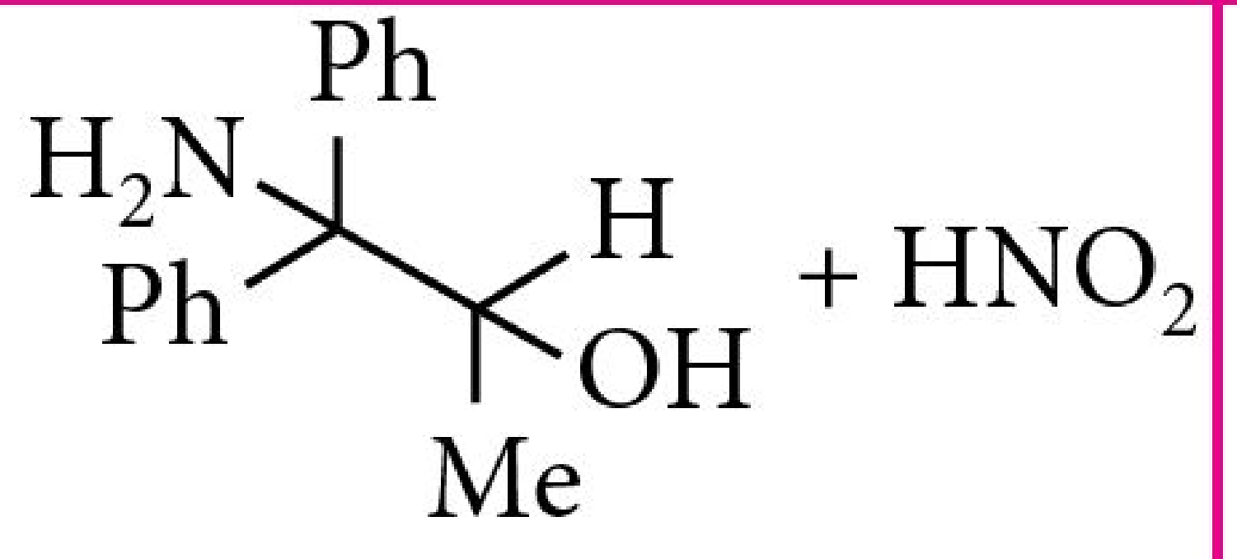
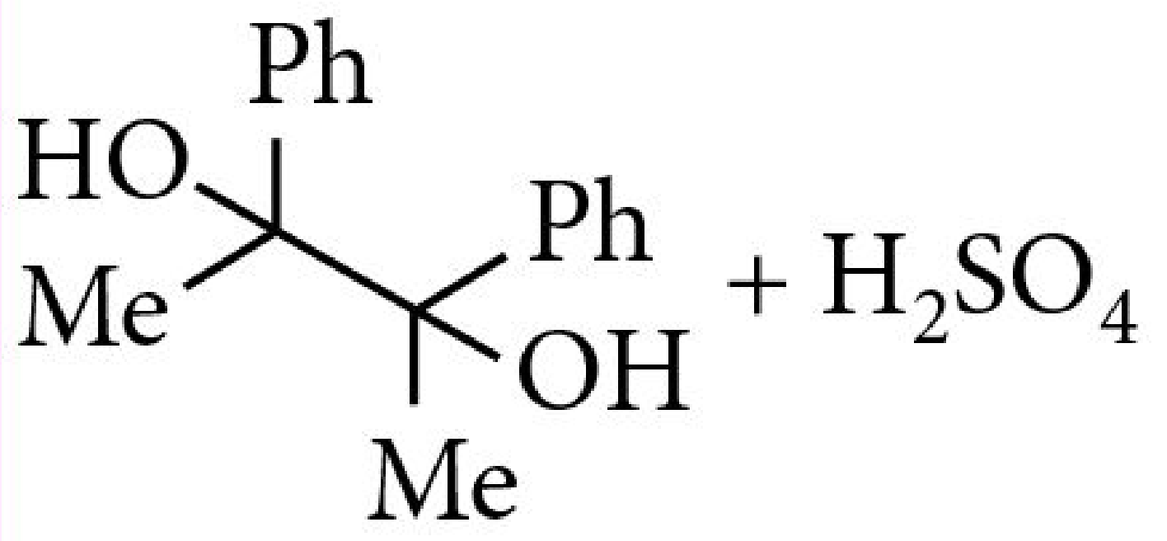
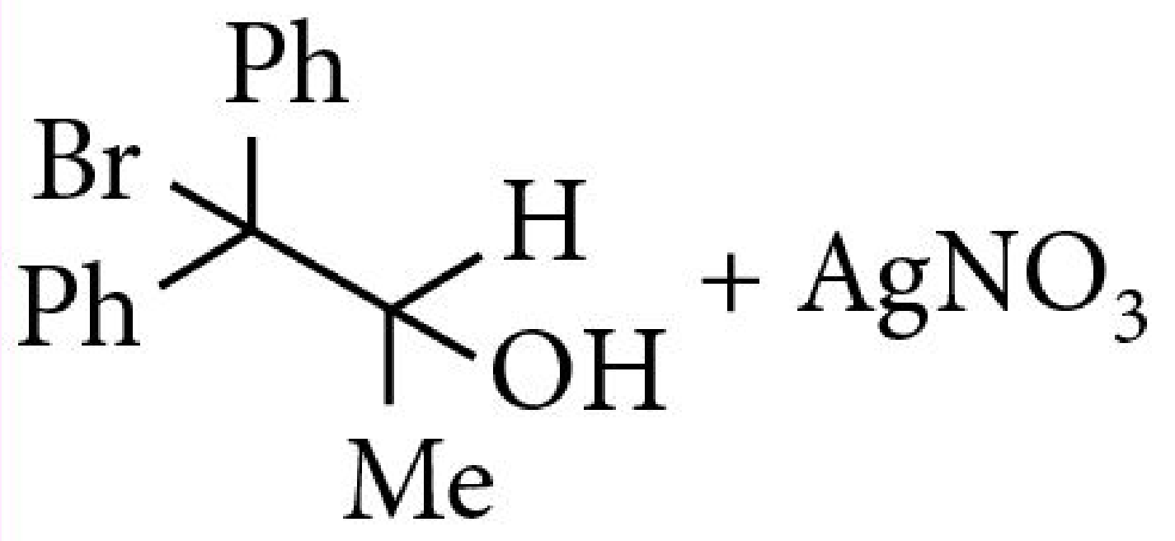
14. Match the reactions in Column I with appropriate options in Column II.

Column I		Column II	
(P)		1.	Racemic mixture
(Q)		2.	Addition reaction
(R)		3.	Substitution reaction
(S)		4.	Coupling reaction
		5.	Carbocation intermediate

The correct option is
(a) (P) – 1; (Q) – 4; (R) – 2; (S) – 3
(b) (P) – 4; (Q) – 5; (R) – 1; (S) – 3
(c) (P) – 1; (Q) – 2; (R) – 4; (S) – 3
(d) (P) – 3; (Q) – 5; (R) – 1; (S) – 4

15. The desired product can be prepared by reacting the major product of the reactions in List-I with one or more appropriate reagents in List-II. (given, order of migratory aptitude: aryl > alkyl > hydrogen)



List-I		List-II	
P.		1.	I_2, NaOH
Q.		2.	$[Ag(NH_3)_2]OH$
R.		3.	Fehling solution
S.		4.	HCHO, NaOH
		5.	NaOBr

The correct option is
(a) (P) – 2; (Q) – 4; (R) – 1; (S) – 5
(b) (P) – 5; (Q) – 1; (R) – 3; (S) – 4
(c) (P) – 4; (Q) – 5; (R) – 2; (S) – 1
(d) (P) – 5; (Q) – 3; (R) – 1; (S) – 2

16. Dilution processes of different aqueous solutions, with water, are given in List-I. The effects of dilution of the solutions on $[H^+]$ are given in List-II.
(Note: Degree of dissociation (α) of weak acid and weak base is <<1; degree of hydrolysis of salt <<1; $[H^+]$ represents the concentration of H^+ ions)

List-I		List-II	
P.	(10 mL of 0.1 M NaOH + 20 mL of 0.1 M acetic acid) diluted to 60 mL	1.	The value of $[H^+]$ does not change on dilution
Q.	(20 mL of 0.1 M NaOH + 20 mL of 0.1 M acetic acid) diluted to 80 mL	2.	The value of $[H^+]$ changes to half of its initial value on dilution
R.	(20 mL of 0.1 M HCl + 20 mL of 0.1 M ammonia solution) diluted to 80 mL	3.	The value of $[H^+]$ changes to two times of its initial value on dilution

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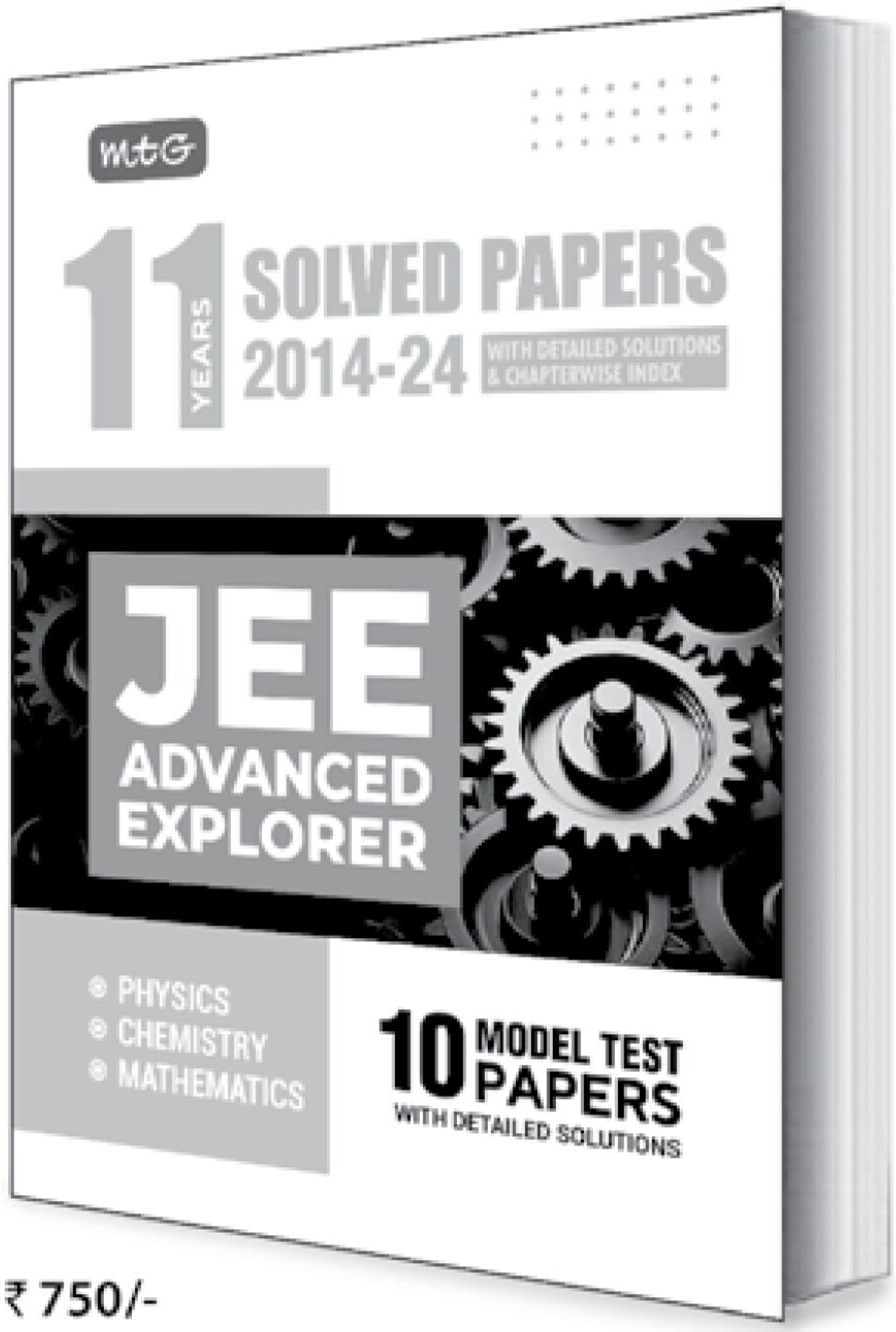
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S.	10 mL saturated solution of $Ni(OH)_2$ in equilibrium with excess solid $Ni(OH)_2$ is diluted to 20 mL (solid $Ni(OH)_2$ is still present after dilution).	4.	The value of $[H^+]$ changes to $\frac{1}{\sqrt{2}}$ times of its initial value on dilution
		5.	The value of $[H^+]$ changes to $\sqrt{2}$ times of its initial value on dilution

Match each process given in List-I with one or more effect(s) in List-II.

The correct option is

(a) $P \rightarrow 4; Q \rightarrow 2; R \rightarrow 3; S \rightarrow 1$

(b) $P \rightarrow 4; Q \rightarrow 3; R \rightarrow 2; S \rightarrow 3$

(c) $P \rightarrow 1; Q \rightarrow 4; R \rightarrow 5; S \rightarrow 3$

(d) $P \rightarrow 1; Q \rightarrow 5; R \rightarrow 4; S \rightarrow 1$

17. Match the List I with List II and select the correct answer using the code given below the lists :

List-I		List-II	
(P)	Carnallite	1.	Zinc
(Q)	Calamine	2.	Titanium
(R)	Ilmenite	3.	Magnesium
(S)	Chalcopyrite	4.	Copper
		5.	Platinum

(a) (P) – 1 ; (Q) – 4 ; (R) – 2 ; (S) – 3

(b) (P) – 1 ; (Q) – 5 ; (R) – 4 ; (S) – 2

(c) (P) – 3 ; (Q) – 1; (R) – 4 ; (S) – 5

(d) (P) – 3 ; (Q) – 1; (R) – 2 ; (S) – 4

PAPER-II

SECTION 1 (MAXIMUM MARKS : 12)

- *This section contains FOUR (04) questions.*
- *Each question has FOUR options (a), (b), (c) and (d). ONLY ONE of these four options is the correct answer.*
- *For each question, choose the option corresponding to the correct answer.*
- *Answer to each question will be evaluated according to the following marking scheme:*

Full Marks : +3 If ONLY the correct option is chosen;
Zero Marks : 0 If none of the options is chosen (i.e., the question is unanswered);
Negative Marks : –1 In all other cases.

1. Consider a molecule with formula XY_2H_8, where H indicate hydrogen atom. The molecule passes the following properties:

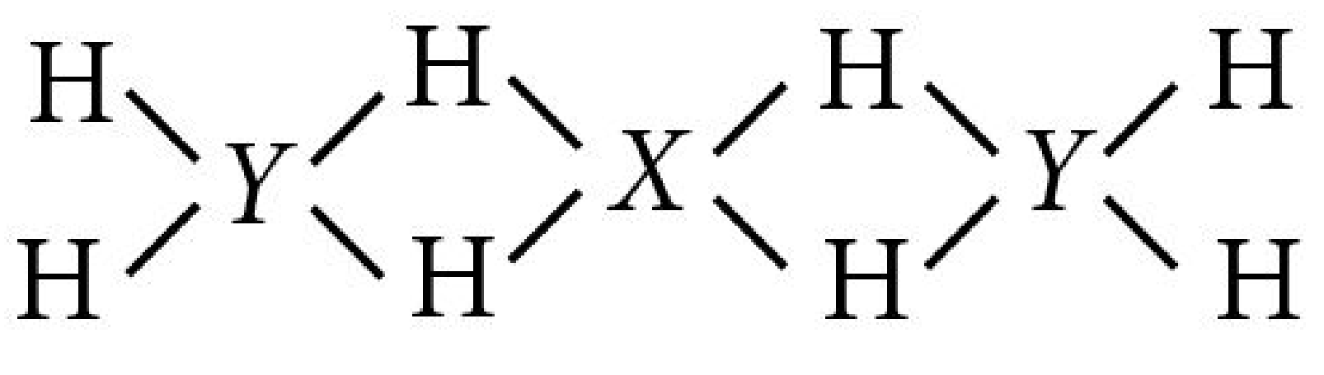
(i) The valence electron present in X and Y are 2 and 3 respectively.

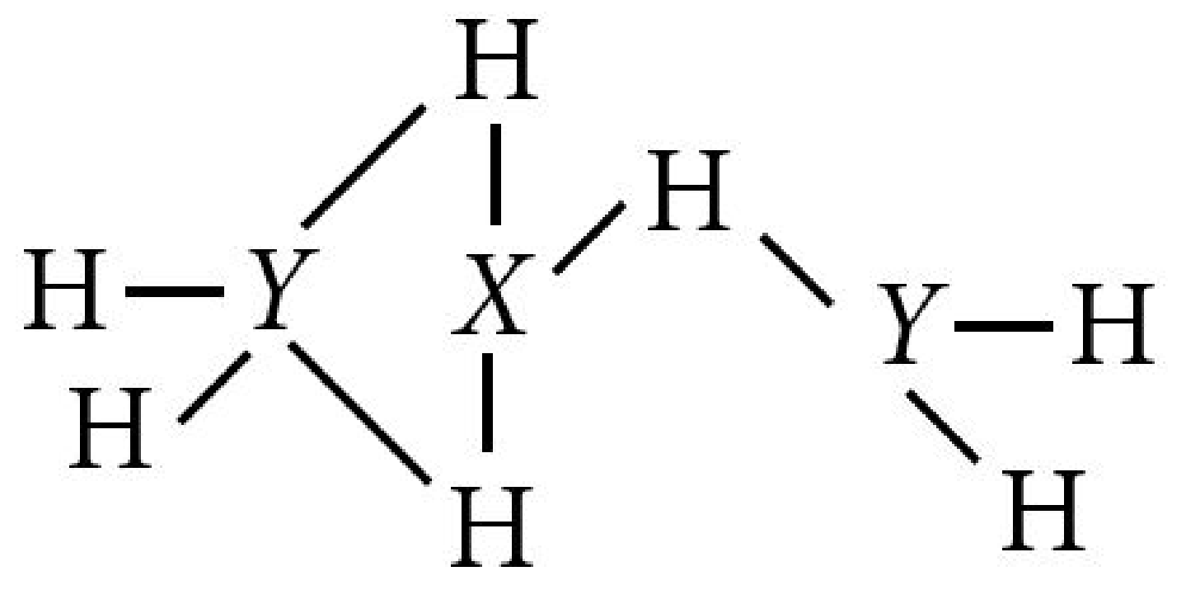
(ii) The elements X and Y belong to period 2 of the periodic table.

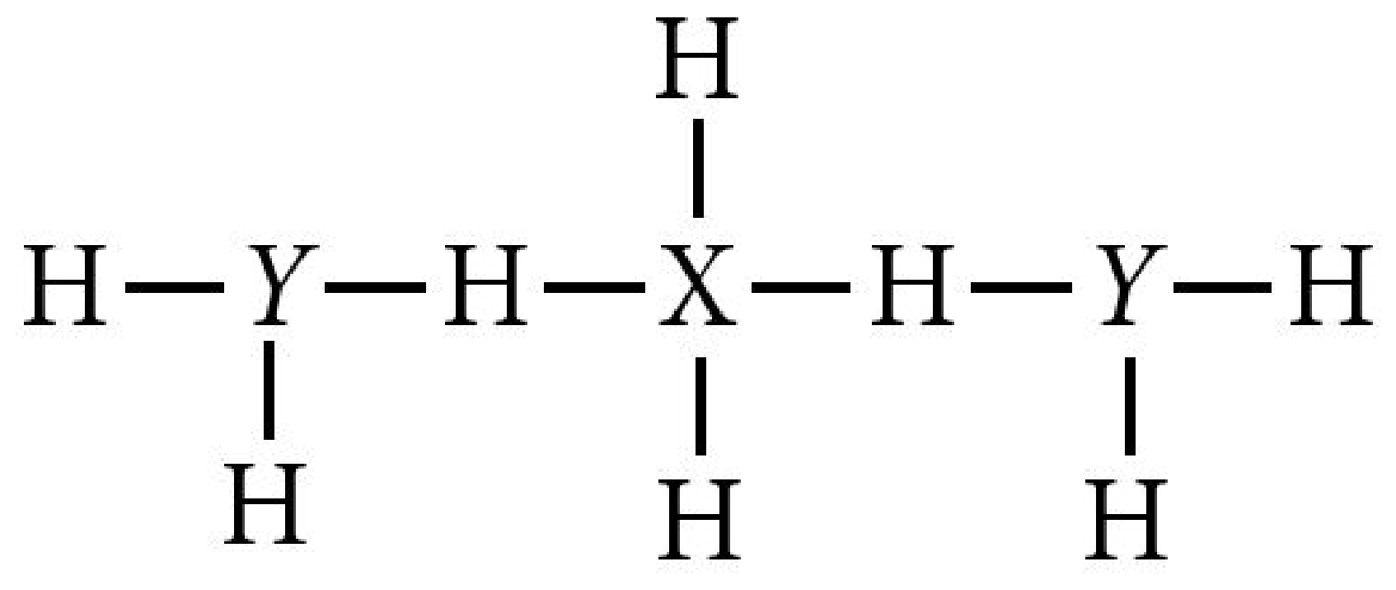
(iii) The molecule contains 4, two centre-two electron bonds and 4, three centre-two electrons bonds.

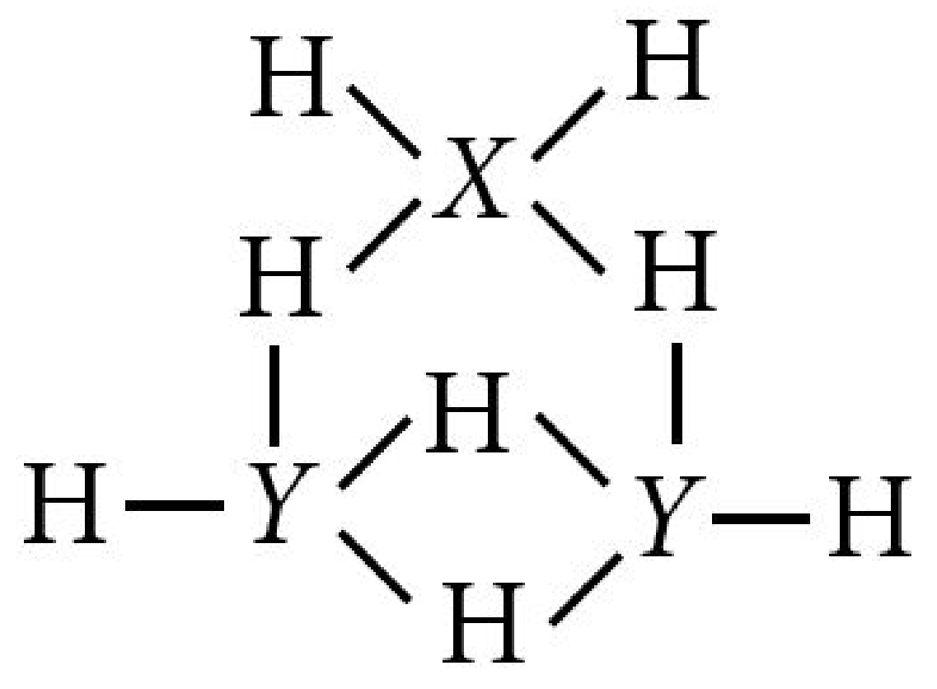
(iv) At least 1, two centre-two electron bond is formed by X as well as Y.

The structure which is most suitable for the given compound on the basis of given information is

(a)


(b)


(c)


(d)


2. A transition metal '*A*' has spin only magnetic moment value of 1.8 B.M. When it is reacted with dilute H_2SO_4 in presence of air, its compound '*B*' is formed. '*B*' reacts with compound '*C*' to give compound '*D*' with liberation of iodine. Then, the metal *A*, compounds *B*, *C* and '*D*' are respectively

(a) Ti, $TiSO_4$, KI and TiI_2

(b) Zn, $ZnSO_4$, KI and ZnI_2

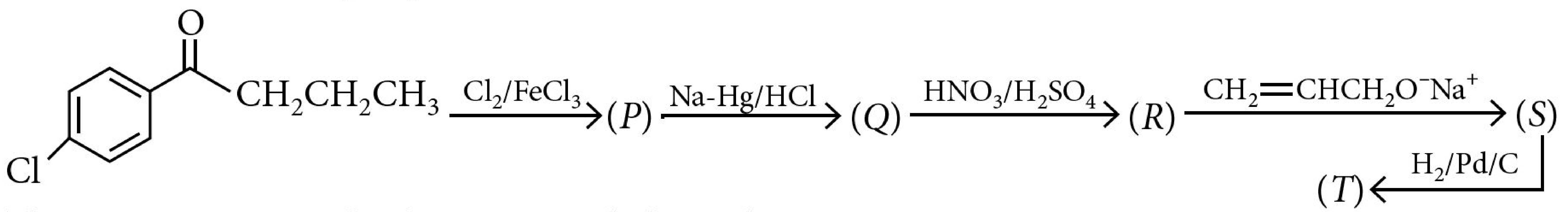
(c) Cu, $CuSO_4$, KI and Cu_2I_2

(d) Cu, $CuSO_4$, KI and CuI_2

3. Graph between $\log\frac{x}{m}$ and $\log P$ is a straight line inclined at an angle, $\theta = 45°$. When pressure of 0.5 atm and $\log k = 0.699$, the amount of solute adsorbed per gram of adsorbent will be

(a) 1 g (b) 1.5 g (c) 2.5 g (d) 0.25 g

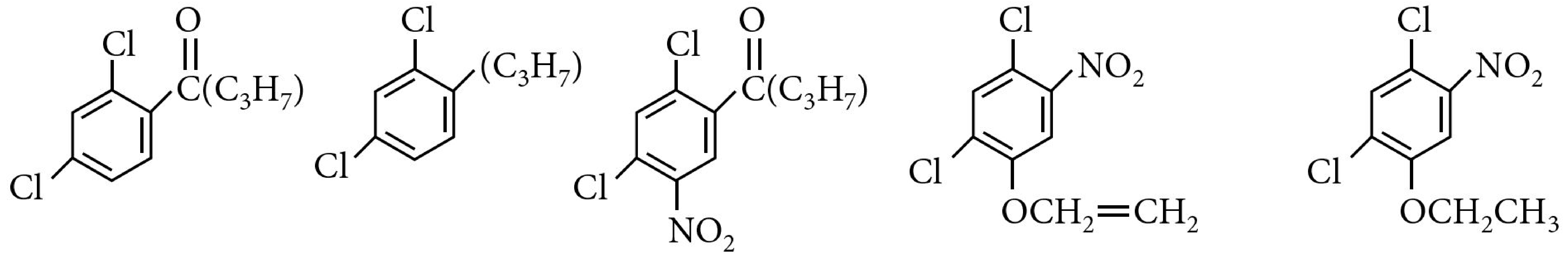
4. Consider the following sequence of reaction:


O
Cl
$CH_2CH_2CH_3$
$Cl_2/FeCl_3$
(P)
Na-Hg/HCl
(Q)
HNO_3/H_2SO_4
(R)
$CH_2{=}CHCH_2O^-Na^+$
(S)
$H_2/Pd/C$
(T)

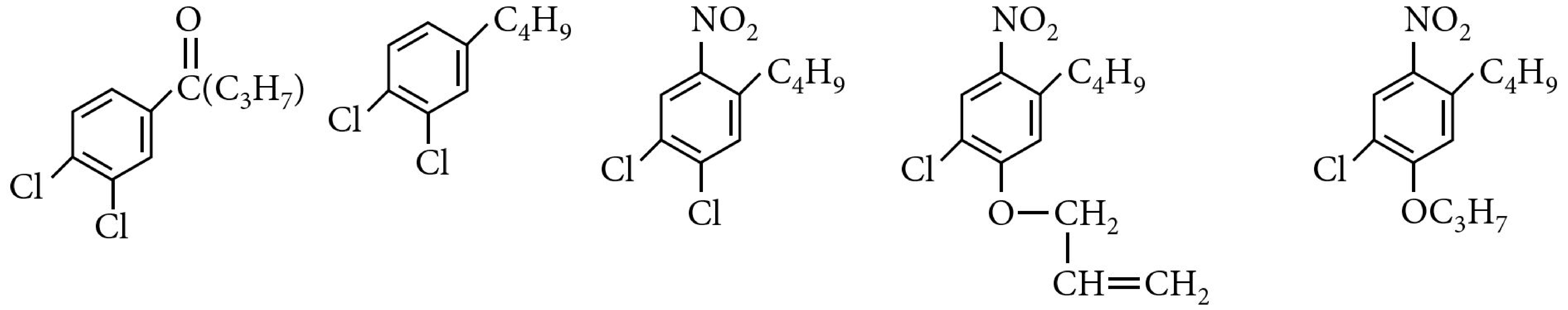
The correct structure for the compounds formed are:

(***P***) (***Q***) (***R***) (***S***) (***T***)

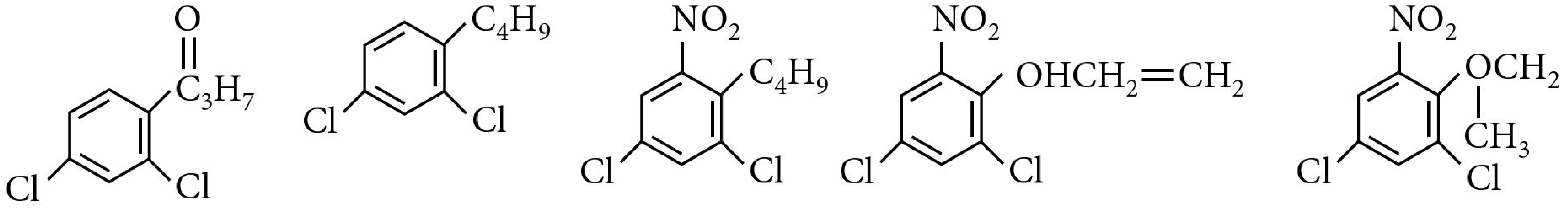
(a)


Cl
O
C(C₃H₇)
Cl
Cl
(C₃H₇)
Cl
Cl
O
C(C₃H₇)
Cl
NO₂
Cl
NO₂
Cl
OCH₂=CH₂
Cl
NO₂
Cl
OCH₂CH₃

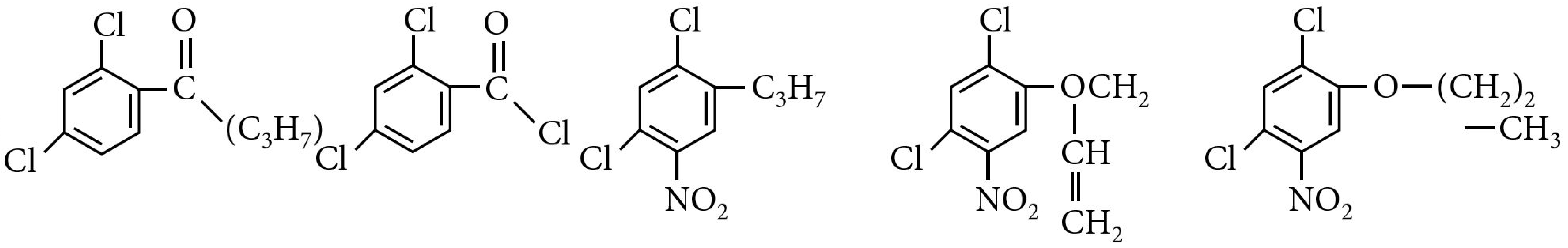
(b)


O
C(C₃H₇)
Cl
Cl
C₄H₉
Cl
Cl
NO₂
C₄H₉
Cl
Cl
NO₂
C₄H₉
Cl
O–CH₂
CH=CH₂
NO₂
C₄H₉
Cl
OC₃H₇

(c)


O
C₃H₇
Cl
Cl
C₄H₉
Cl
Cl
NO₂
C₄H₉
Cl
Cl
NO₂
OHCH₂=CH₂
Cl
Cl
NO₂
OCH₂
CH₃
Cl
Cl

(d)


Cl
O
C
(C₃H₇)
Cl
Cl
O
C
Cl
Cl
Cl
C₃H₇
Cl
NO₂
Cl
OCH₂
CH
CH₂
Cl
NO₂
Cl
O–(CH₂)₂
–CH₃
Cl
NO₂

SECTION 2 (MAXIMUM MARKS : 12)

- *This section contains THREE (03) questions.*
- *Each question has FOUR options (a), (b), (c) and (d). ONE OR MORE THAN ONE of these four option(s) is(are) correct answer(s).*
- *For each question, choose the option(s) corresponding to (all) the correct answer(s).*
- *Answer to each question will be evaluated according to the following marking scheme:*

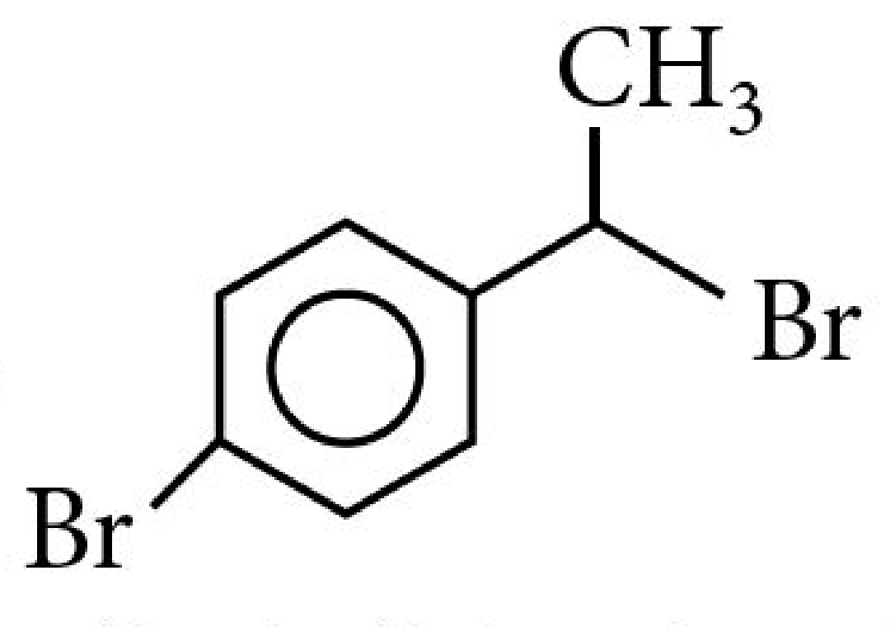
Full Marks : +4 ONLY if (all) the correct option(s) is(are) chosen;
Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;
Partial Marks : +2 If three or more options are correct but ONLY two options are chosen, both of which are correct;
Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks : 0 If unanswered;
Negative Marks : –2 In all other cases.

5. An aromatic chiral compound $G(C_8H_8Br_2)$ on treatment with aqueous NaOH gives $H(C_8H_9BrO)$. On heating G with potassium *tert*-butoxide, $I(C_8H_7Br)$ is formed. With one equivalent of methyl magnesium bromide in ether *p*-bromo isopropylbenzene is formed. Which observation/s is/are correct about these reactions?

(a) (I) is an optically inactive aromatic alkene

(b) (H) is an optically active phenol

(c) G =



(d) benzylic halide gives S_N1 reaction with faster rate than alkyl halide

6. Which of the following statements is/are not correct?

(a) The molecular mass corresponding to a non-volatile organic molecule is determined either by Dumas method or by Victor Meyer's method.

(b) When Lassaigne's extract is heated with dil. HNO_3. cooled, and $AgNO_3$ solution is added, a yellow precipitate partially soluble in NH_3 or NH_4OH, indicates the presence of iodine is organic compounds.

(c) On adding $(CH_3COO)_4Pb$ solution to the acidified Lassaigne extract of an organic compound, formation of black precipitate of PbS takes place.

(d) An organic compound containing N, on heating with conc. H_2SO_4 gives $(NH_4)_2SO_4$ which liberates NH_3 on treatment with excess of NaOH.

7. Diborane undergoes cleavage reactions with

(a) trimethylamine (b) ammonia

(c) carbon monoxide (d) carbon dioxide.

SECTION 3 (MAXIMUM MARKS : 24)

- *This section contains SIX (06) questions.*
- *The answer to each question is a NON-NEGATIVE INTEGER.*
- *Answer to each question will be evaluated according to the following marking scheme:*

Full Marks : +4 If ONLY the correct integer is entered;

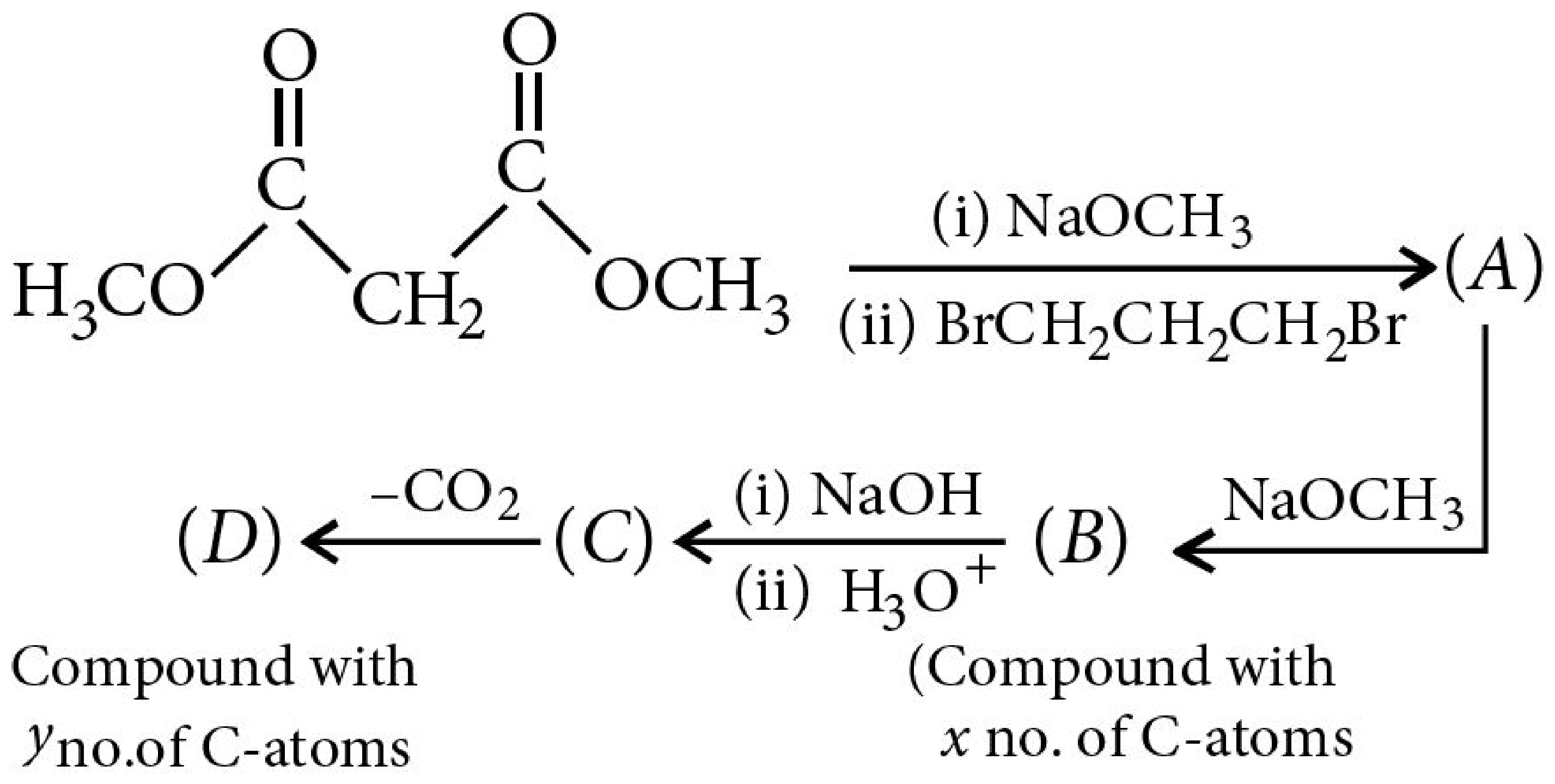
Zero Marks : 0 In all other cases.

8. Temperature of 1 mole of a gas is increased by 1° at constant pressure. Work done in cal mol^{-1} K^{-1} is ________.

9. A mixture of water and nitrobenzene boils at 99°C. In the vapours of mixture, partial vapour pressures of water and nitrobenzene are 733 mm Hg and 27 mm Hg respectively. The $W_{H_2O}/W_{C_6H_5NO_2}$ is ________.

10. Compound$(X)(C_5H_8O)$ does not react appreciably with Lucas reagent at room temperature, but gives a precipitate with ammoniacal silver nitrate. With excess of MeMgBr, 0.42 g of (X) gives 224 ml CH_4 at STP. Treatment of (X) with H_2 in presence of Pt catalyst followed by boiling with excess HI gives n-pentane. The number of acidic H-atoms in(X) is ________.

11.



In the above sequence of reactions, $(x - y)$ is

12. The successive ionisation energy values for an element X are given below :

1st ionisation energy = 410 kJ mol^{-1}

2nd ionisation energy = 820 kJ mol^{-1}

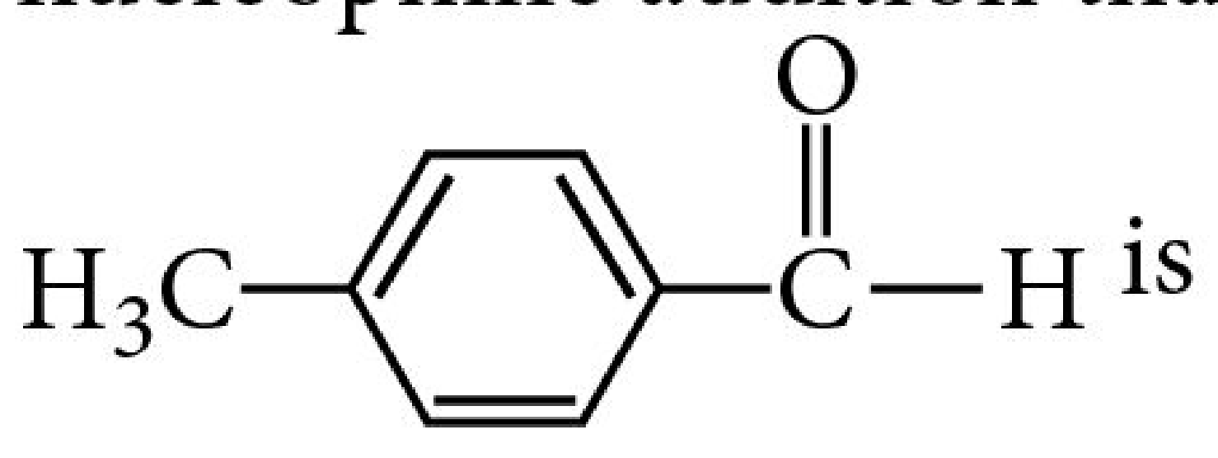
3rd ionisation energy = 1100 kJ mol^{-1}

4th ionisation energy = 1500 kJ mol^{-1}

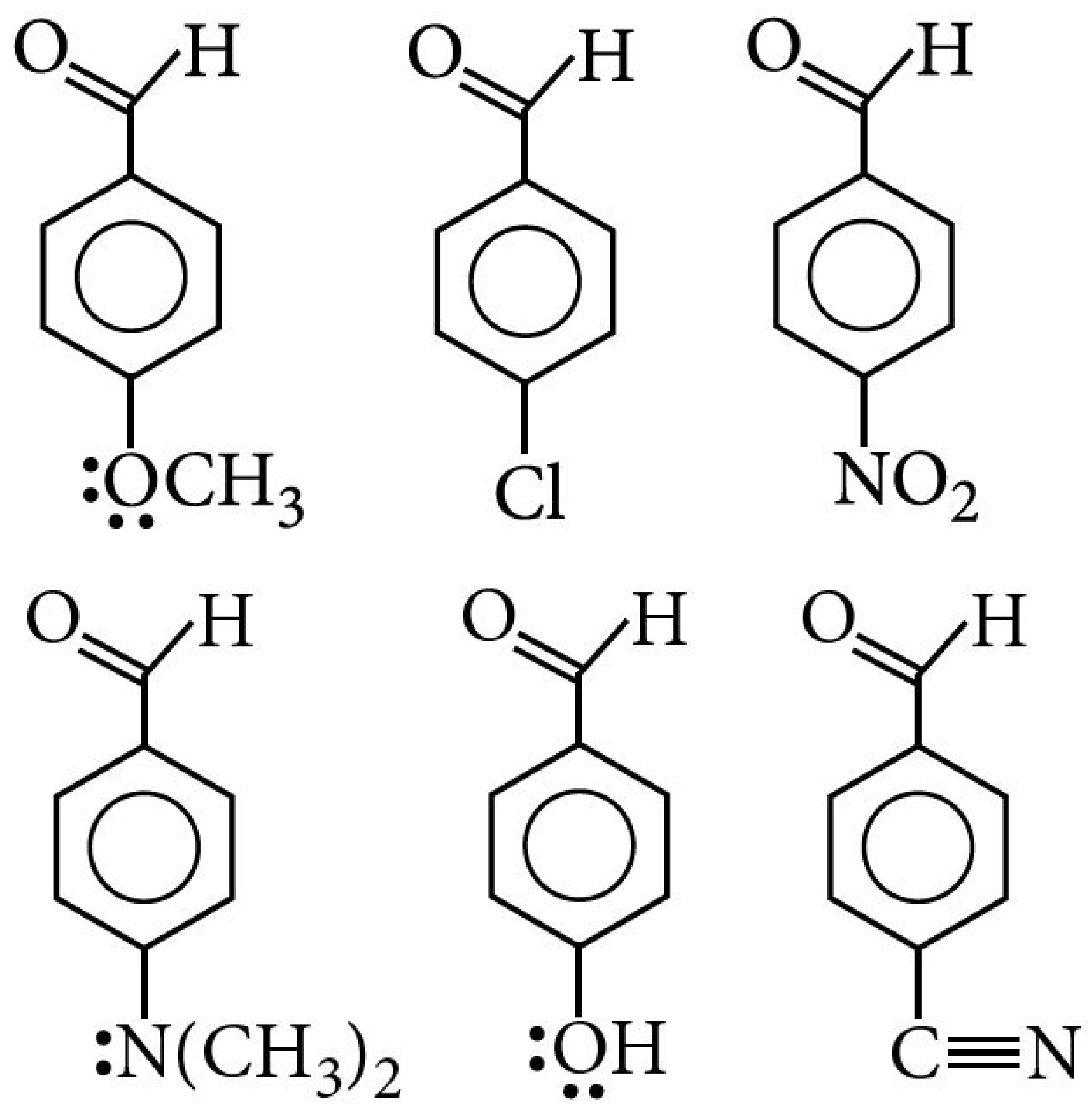
5th ionisation energy = 3200 kJ mol^{-1}

The number of valence electrons for the atom X is

13. From the following compounds, the number of compounds which show(s) higher rate of nucleophilic addition than



is



SECTION 4 (MAXIMUM MARKS : 12)

- *This section contains TWO (02) paragraphs.*
- *Based on each paragraph, there are TWO (02) questions.*
- *The answer to each question is a NUMERICAL VALUE.*
- *If the numerical value has more than two decimal places, truncate/round-off the value to TWO decimal places.*
- *Answer to each question will be evaluated according to the following marking scheme:*

Full Marks : +3 If ONLY the correct numerical value is entered in the designated place;

Zero Marks : 0 In all other cases.

PARAGRAPH-I

Assume that impure copper contains only Fe, Au and Ag as impurities. After passage of 140 ampere for 482.5

sec the mass of anode decreased by 22.260 g and the cathode increased in mass by 22.011 g.

14. Weight of Fe dissolved at anode is ________ g.

15. Percentage of copper originally present is _________ %.

PARAGRAPH-II

The equilibrium for a saturated solution of a sparingly soluble salt A_xB_y may be written as

$$A_xB_y \rightleftharpoons xA^{y+} + yB^{x-}$$

Solubility product, $K_{sp} = [xA^{y+}]^x[yB^{x-}]^y$

For a solution of a salt at a specified concentration, the product of the concentrations of the ions, each raised to the proper power, is called the ionic product. For a saturated solution in equilibrium with excess solid, the ionic product is equal to its solubility product. If the ionic product of the solution is less than the corresponding solubility product, it means that the solution is unsaturated and thus more salt can dissolve in it. On the other hand, if the ionic product exceeds the solubility product, the solution is holding more salt than can dissolve in it; therefore precipitation takes place which continues till the ionic product becomes equal to the solubility product.

16. The K_{sp} of $PbCO_3$ and $MgCO_3$ are 1.5×10^{-15} and 1×10^{-15} respectively at 298 K. The concentration of Pb^{2+} ions in a saturated solution containing $MgCO_3$ and $PbCO_3$ is $x \times 10^{-8}$ M. The value of x is ______.

17. The mass of CaC_2O_4 that will dissolve in 1 L of saturated solution is $y \times 10^{-3}$ g. The value of y is [given : K_{sp} of CaC_2O_4 is 2.5×10^{-9} mol^{-2}].

SOLUTIONS

PAPER-I

1. (a) : SO_2 is oxidised by MnO_4^- in acidic medium,

$$2H_2O + 5SO_2 + 2MnO_4^- \longrightarrow 2Mn^{2+} + 5SO_4^{2-} + 4H^+$$

2 moles of MnO_4^- = 5 moles of SO_2

Hence, 0.4 moles of $MnO_4^- = \frac{5}{2} \times 0.4 = 1$ mole of SO_2

$$\begin{array}{llll} & 2SO_2 & + \; O_2 & \rightleftharpoons \; 2SO_3 \\ \text{Initially :} & 2 & 1 & 0 \\ \text{At equil :} & (2-2x) & (1-x) & 2x \end{array}$$

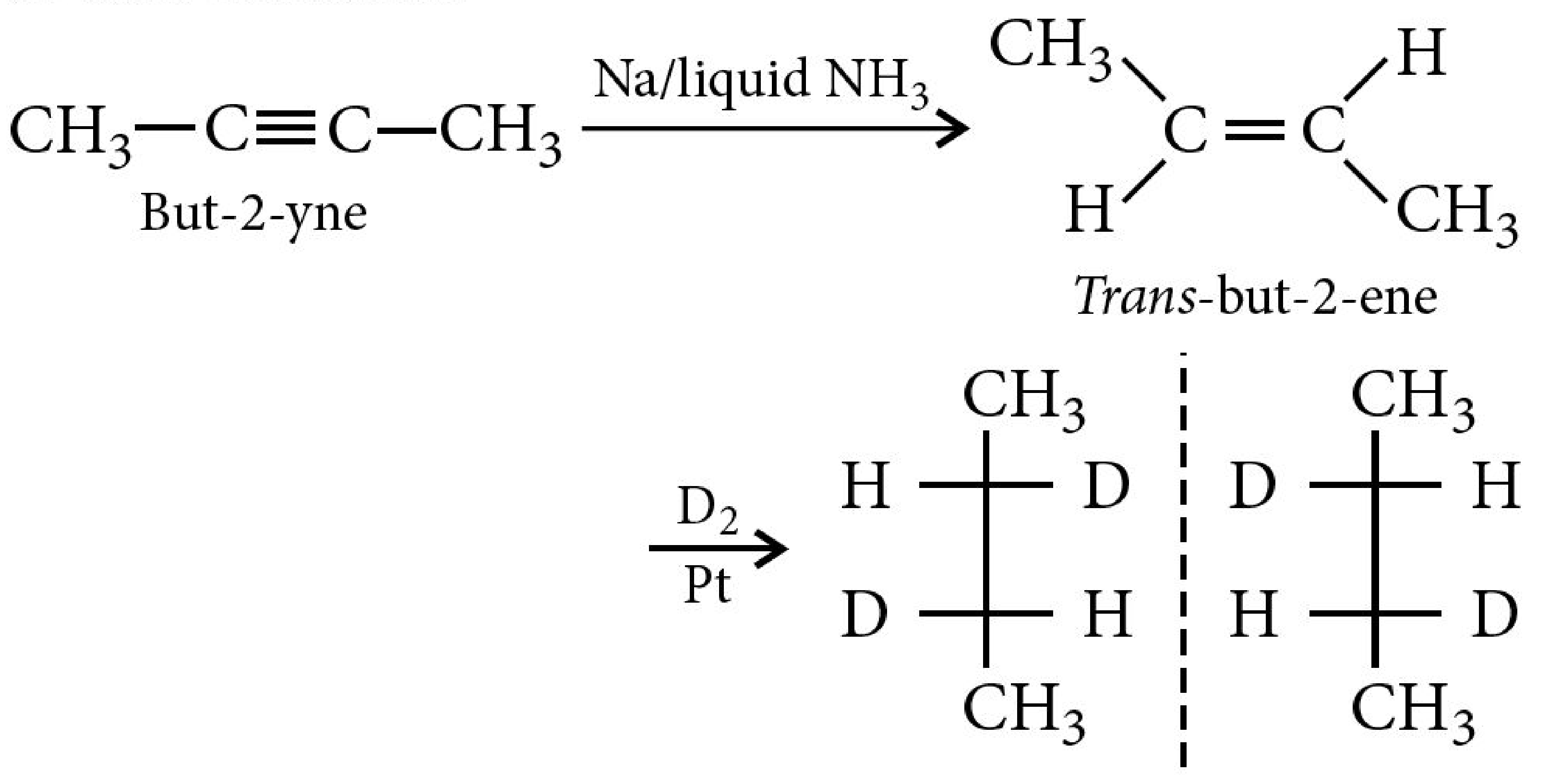
$(2 - 2x)$ = 1 mole of SO_2 (as determined by MnO_4^-)

$x = 0.5$ and $V = 1$ L

$$[SO_3] = \frac{2x}{V} = 1\text{M}, [SO_2] = \frac{2-2x}{V} = 1\text{M}$$

$$\text{and } [O_2] = \frac{1-x}{V} = 0.5\text{M} \quad \therefore K_c = \frac{[SO_3]^2}{[SO_2]^2\,[O_2]} = 2$$

2. (c) : *Trans*-but-2-ene reacts with D_2 (Deuterium or Heavy hydrogen) and Pt to give a racemic mixture due to anti-addition.



(*d*, *l*-forms)

(a) is ruled out because Na/liquid NH_3 leads to anti-addition and forms *trans*-but-2-ene.

(b) is ruled out because *trans*-but-2-ene will react with D_2/Pt to give a racemic mixture and not a meso compound.

(d) is not possible because *Cis*-but-2-ene cannot be formed by Birch reduction.

3. (a) : For *ccp*, $Z = 4$ = no. of O-atoms

No. of octahedral voids = 4

No. of tetrahedral voids = 2 × 4 = 8

No. of Al^{3+} ions = $m \times 4$

No. of Mg^{2+} ions = $n \times 8$

Thus, the formula of the mineral is $Al_{4m}Mg_{8n}O_4$

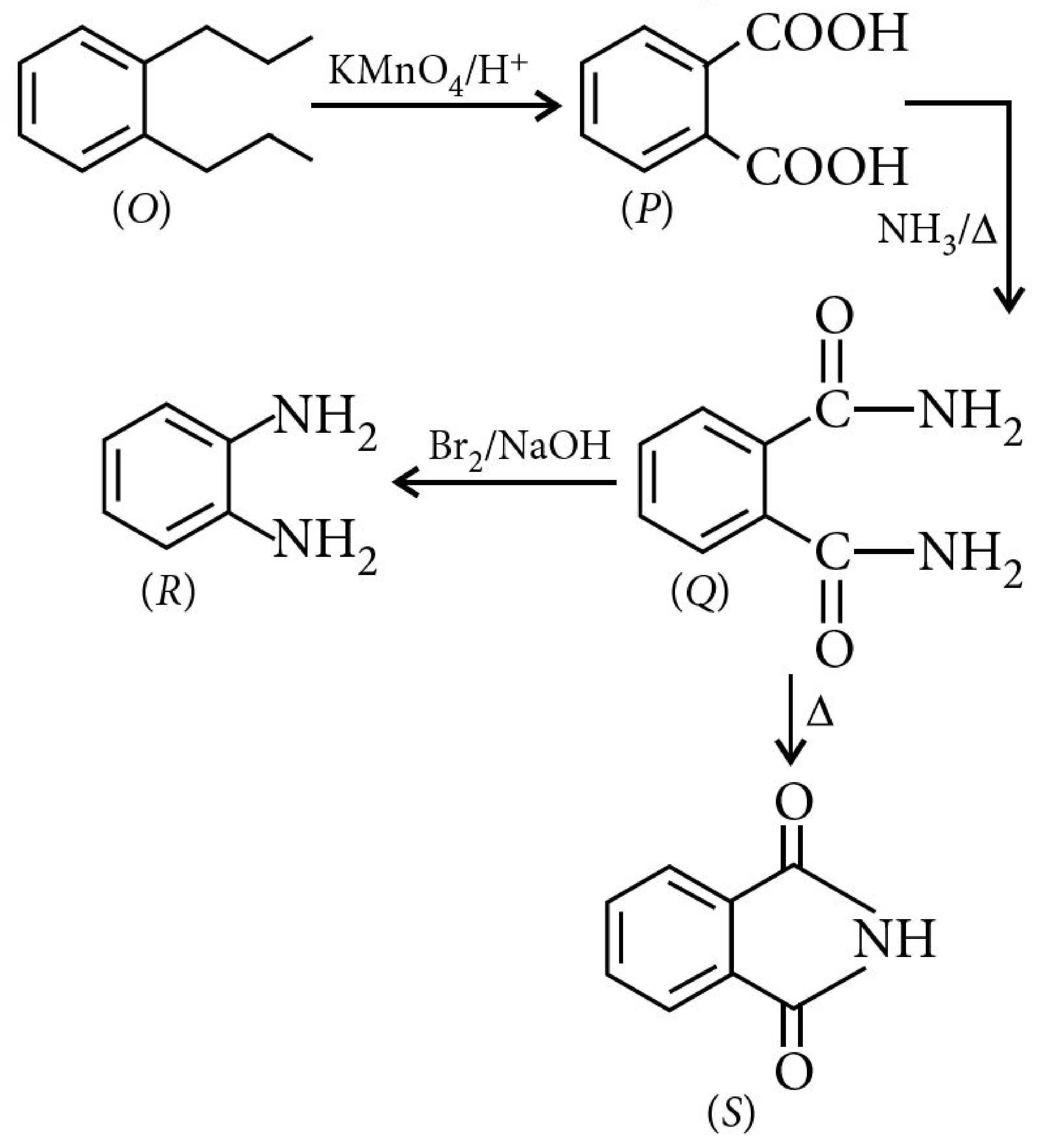
$4m(+3) + 8n(+2) + 4(-2) = 0$

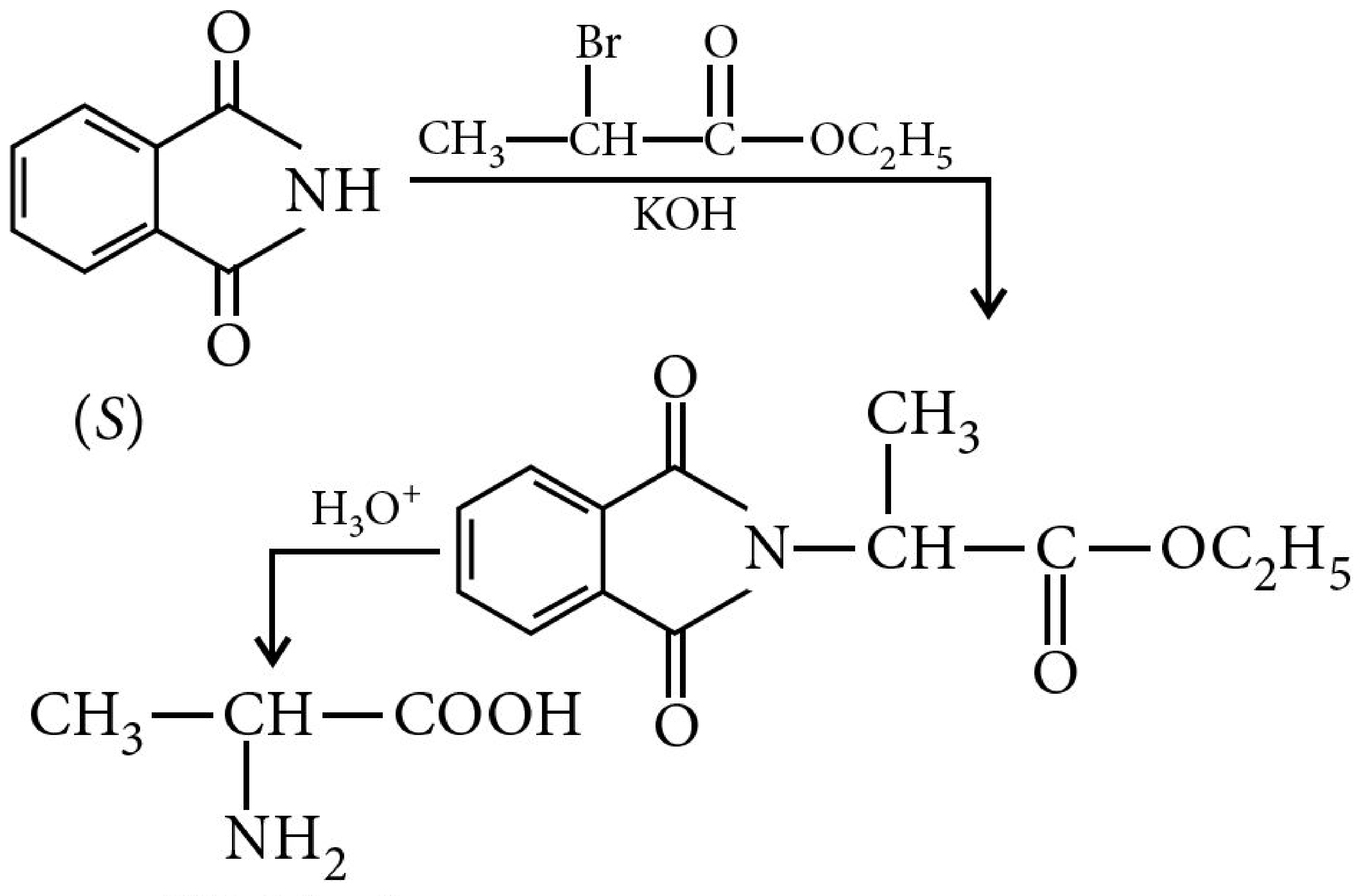
$12m + 16n - 8 = 4(3m + 4n - 2) = 0$

$3m + 4n = 2$

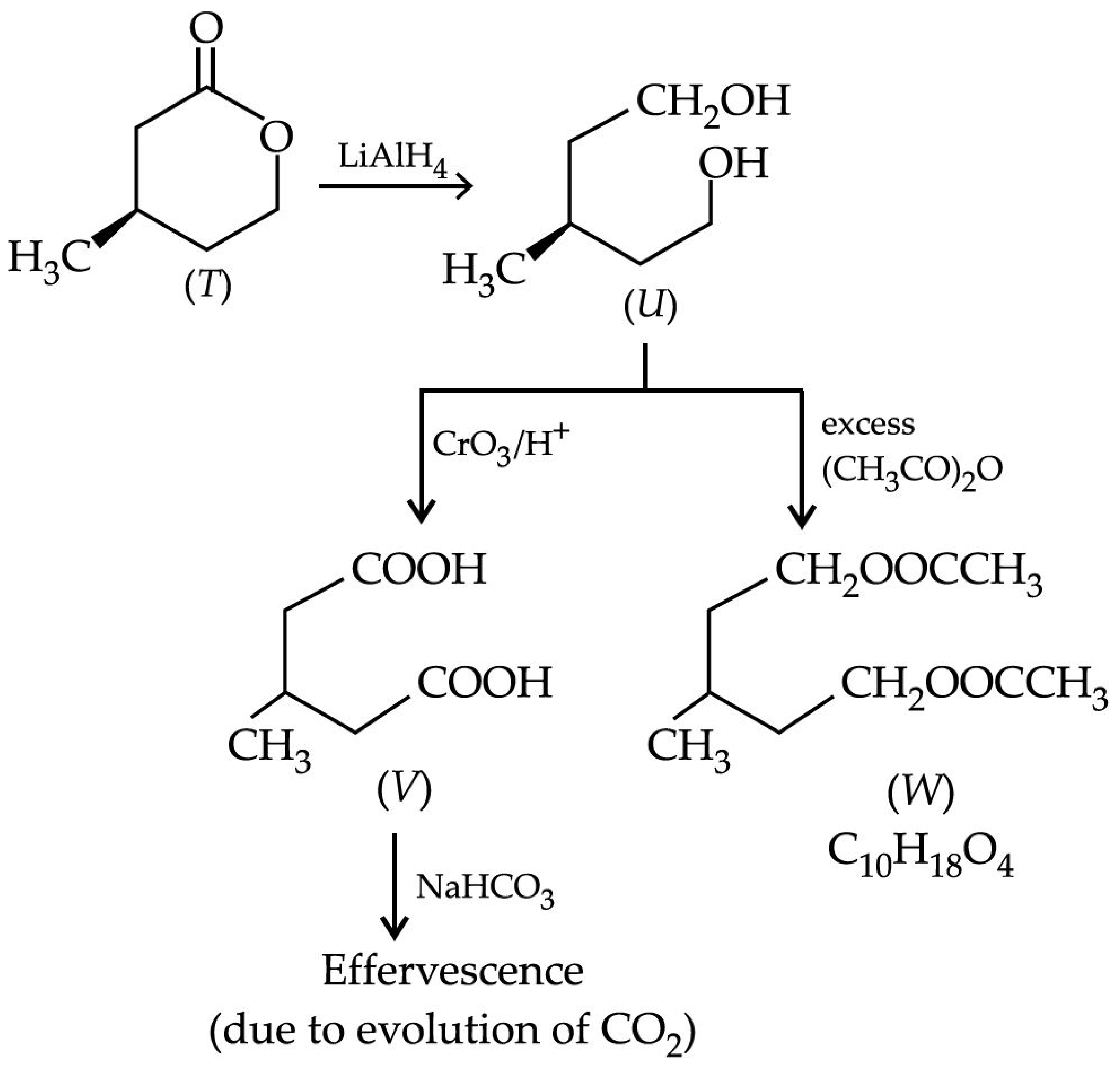
Possible values of m and n are $\frac{1}{2}$ and $\frac{1}{8}$ respectively.

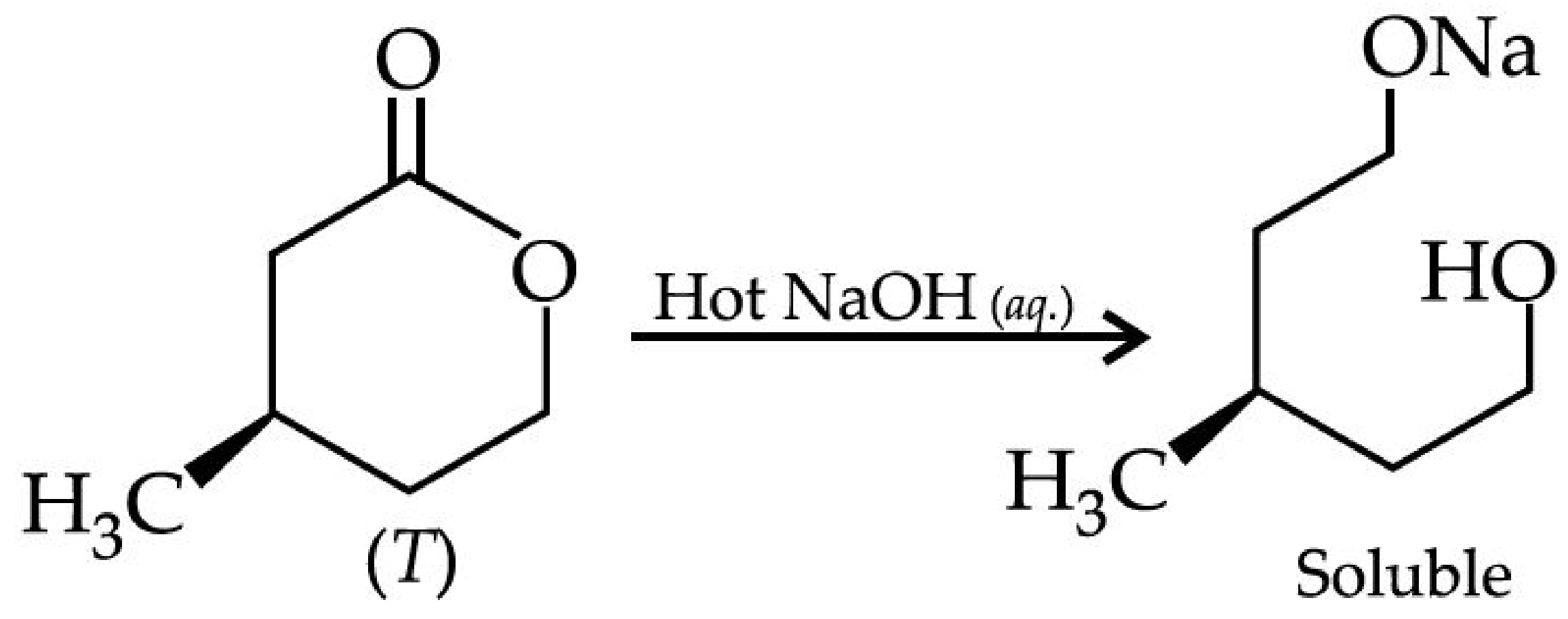
4. (b) :



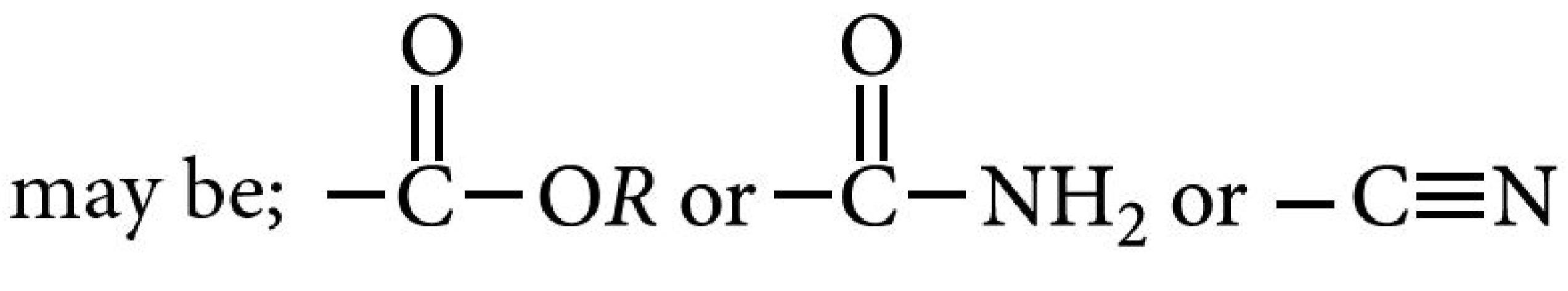

NH
Br
KOH
(S)
H_3O^+
(T) Alanine

5. (a, c, d) :

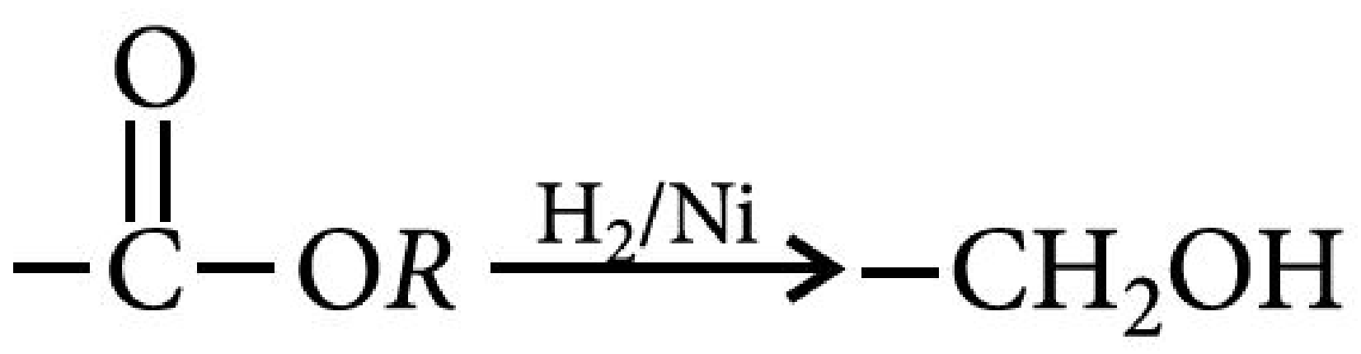

$LiAlH_4$
(T)
(U)
CrO_3/H^+
excess $(CH_3CO)_2O$
(V)
(W) $C_{10}H_{18}O_4$
$NaHCO_3$
Effervescence (due to evolution of CO_2)


Hot NaOH (aq.)
(T)
Soluble

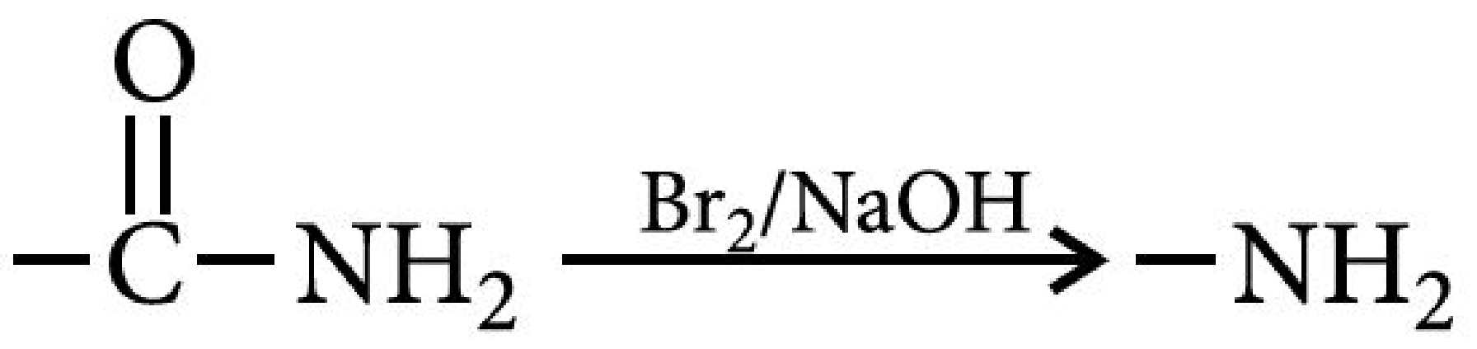
6. (a, b, c, d) : Condensation polymers are formed by condensation of diols or diamines with dicarboxylic acids. Therefore,



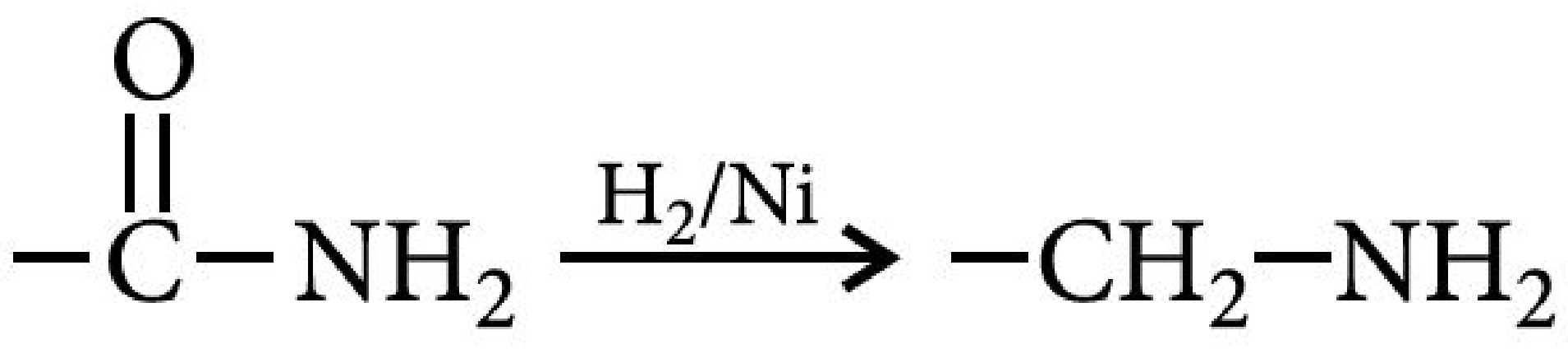
may be; $-\overset{O}{\overset{\|}{C}}-OR$ or $-\overset{O}{\overset{\|}{C}}-NH_2$ or $-C\equiv N$



$$-\overset{O}{\overset{\|}{C}}-OR \xrightarrow{H_2/Ni} -CH_2OH$$



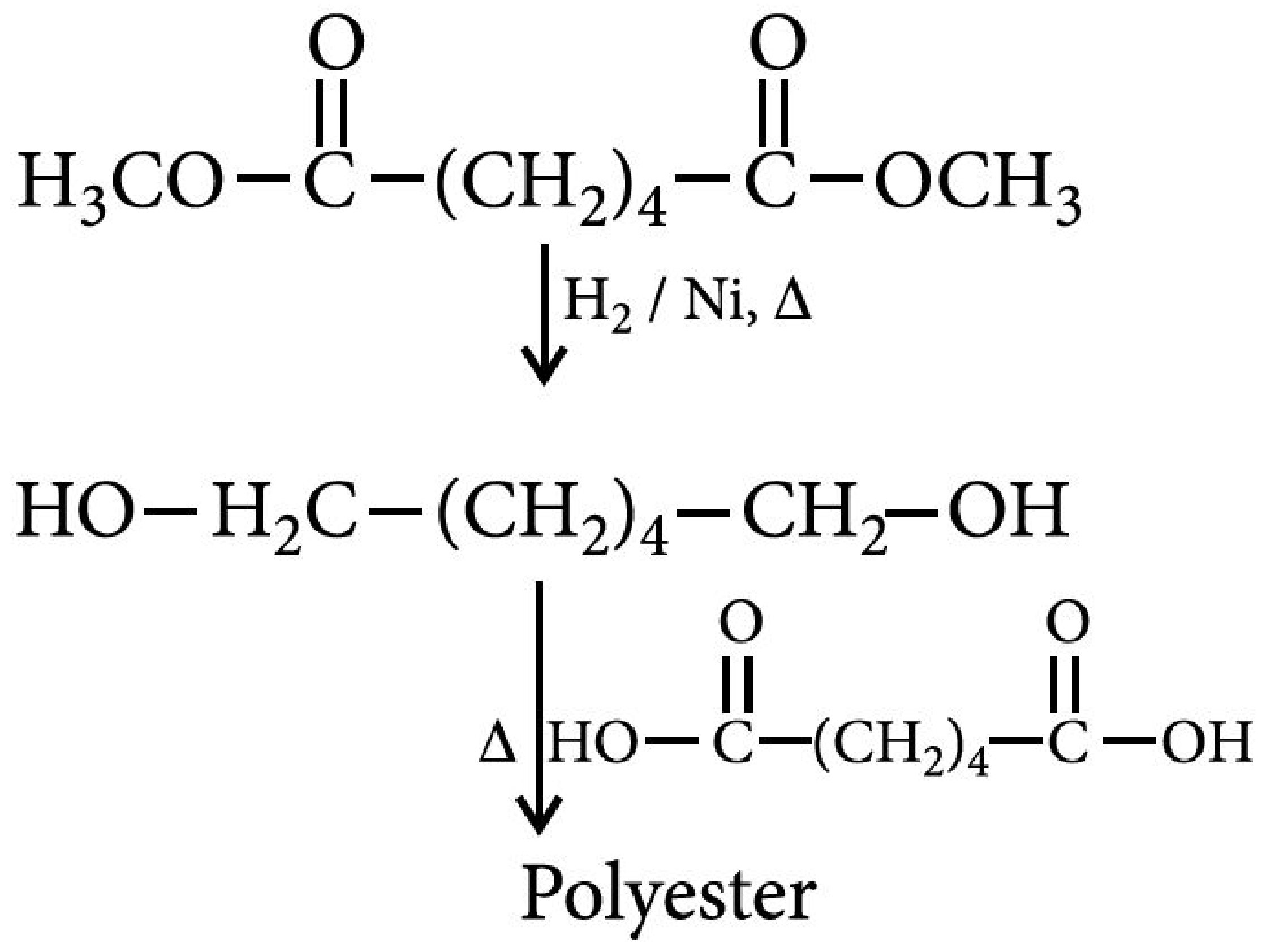
$$-\overset{O}{\overset{\|}{C}}-NH_2 \xrightarrow{Br_2/NaOH} -NH_2$$



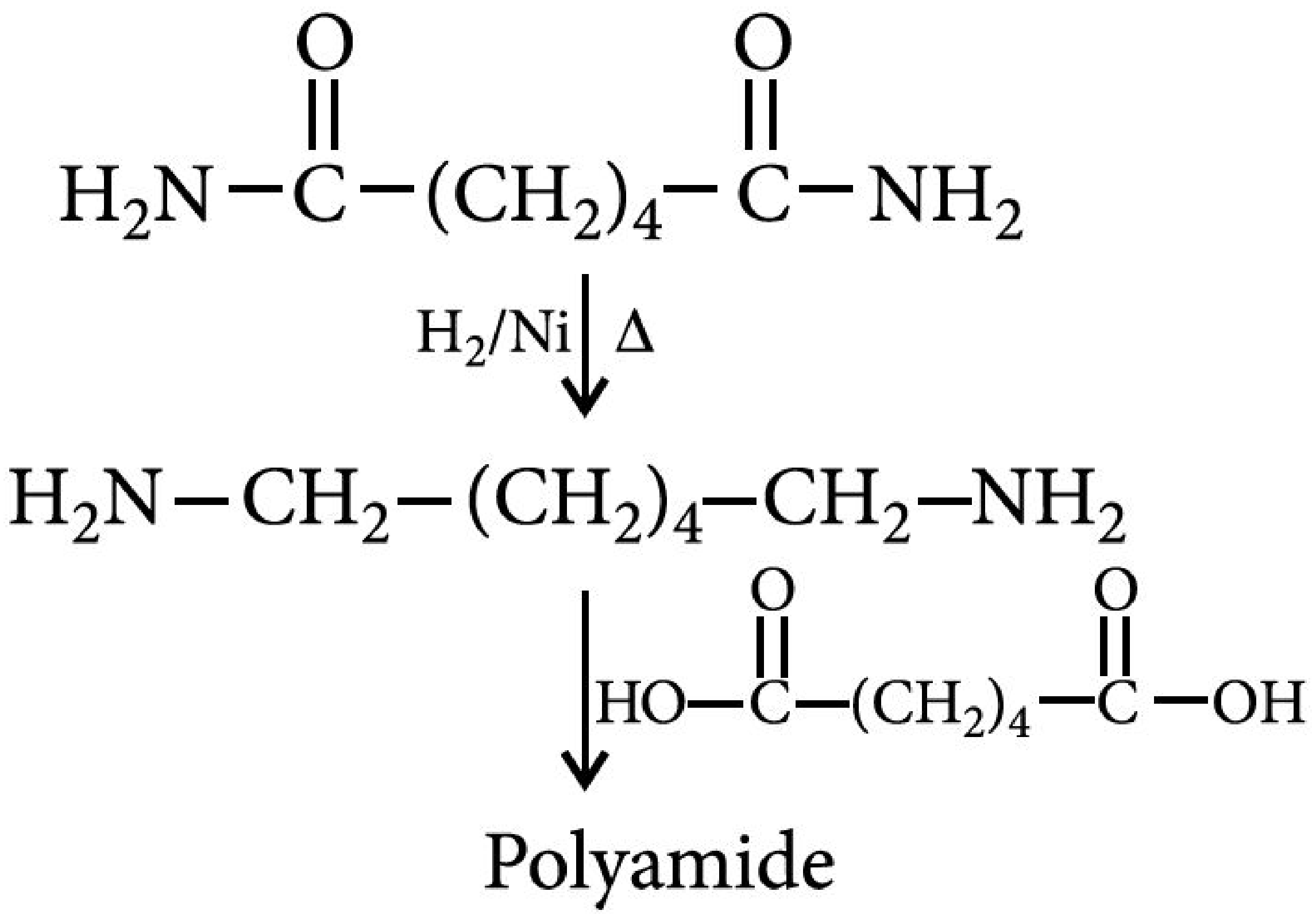
$$-\overset{O}{\overset{\|}{C}}-NH_2 \xrightarrow{H_2/Ni} -CH_2-NH_2$$

$$-C\equiv N \xrightarrow{H_2/Ni} -CH_2-NH_2$$

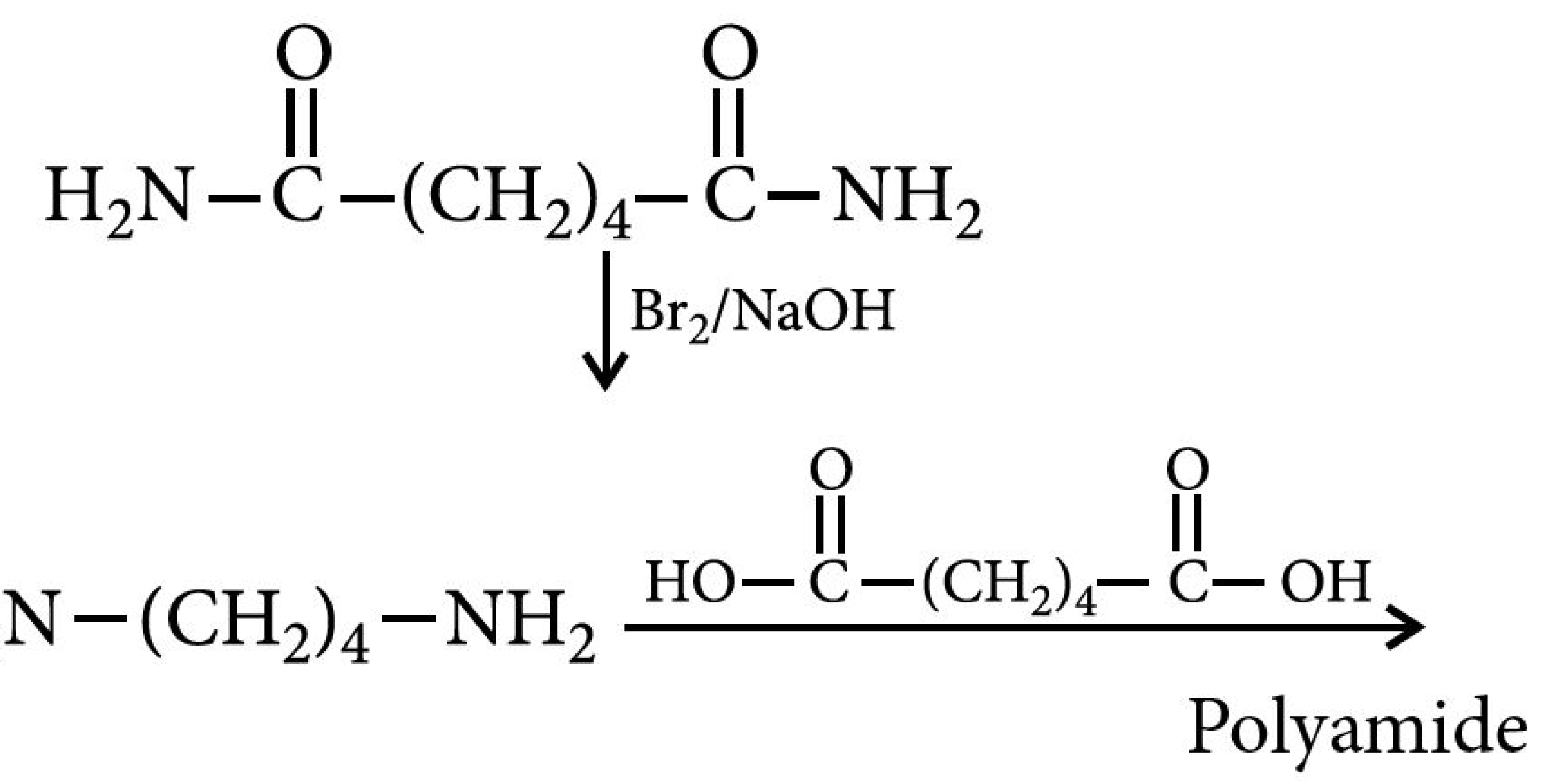
(a)


H_2 / Ni, Δ
Δ
Polyester

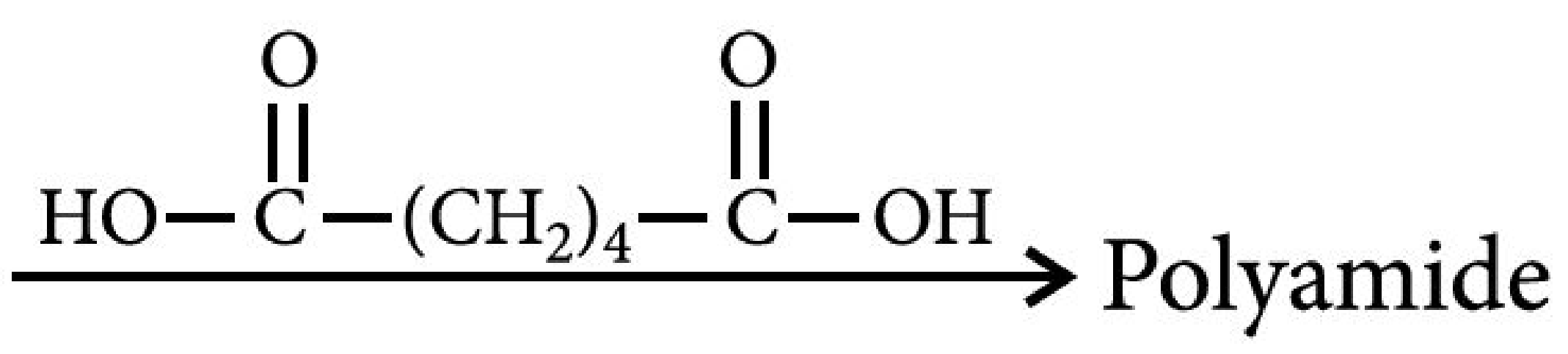
(b)


H_2/Ni Δ
Polyamide

(c)


Br_2/NaOH
Polyamide

(d) $N\equiv C-(CH_2)_4-C\equiv N \xrightarrow{H_2/Ni} H_2NCH_2-(CH_2)_4-CH_2NH_2$



$$\xrightarrow{HO-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-OH} \text{Polyamide}$$

7. (a, b, c, d)

8. (3) : In case of H-atom, the energies of the orbitals are in the order :

$1s < 2s = 2p < 3s = 3p = 3d < 4s = 4p = 4d = 4f <$ ......

For multielectronic system, *i.e.*, H^- ion, the order is :

$1s < 2s < 2p$ ...... [follow $(n + l)$ rule]

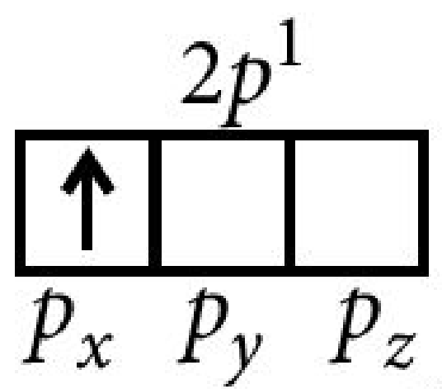
For H-atom, $Z = 1$, $1s^1$, the second excited state ($n = 3$) is : $\underset{1}{3s} = \underset{3}{3p} = \underset{5}{3d}$

Degenerate orbitals

∴ Degeneracy = 1 + 3 + 5 = 9

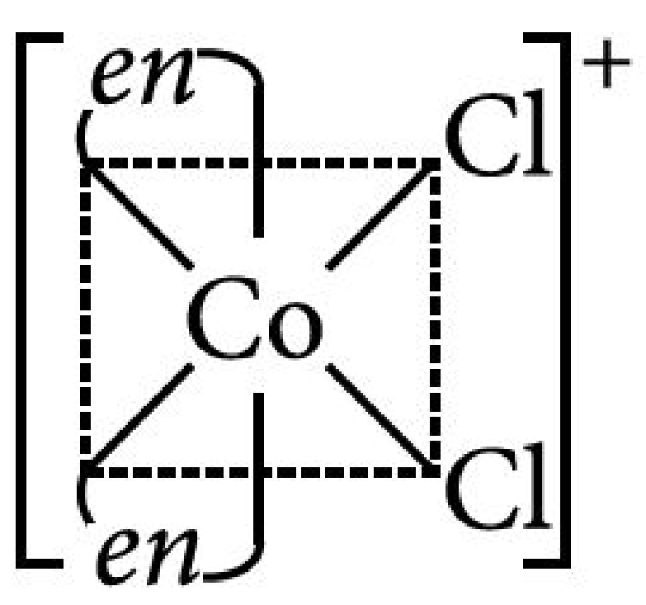
For H^- ion, $Z = 1$, $1s^2$, the first excited state would be $1s^1$, $2s^1$.

And the second excited state would be $1s^1$, $2s^0$, $2p^1$



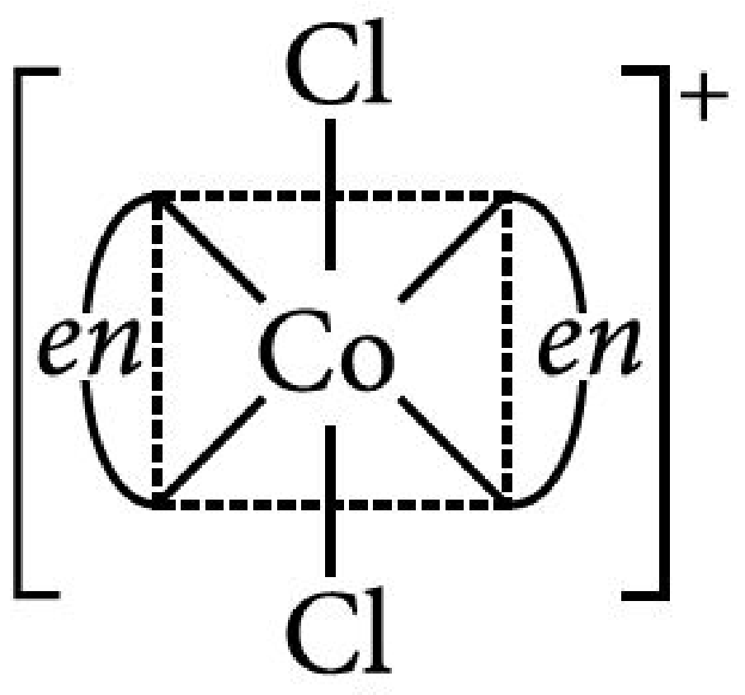
(3 degenerate orbitals) ∴ Degeneracy = 3

9. (6) : $[Co(en)_2Cl_2]^+$ – $[M(AA)_2B_2]$ type complex, shows geometrical isomerism.



en
Cl
Co
Cl
en
+

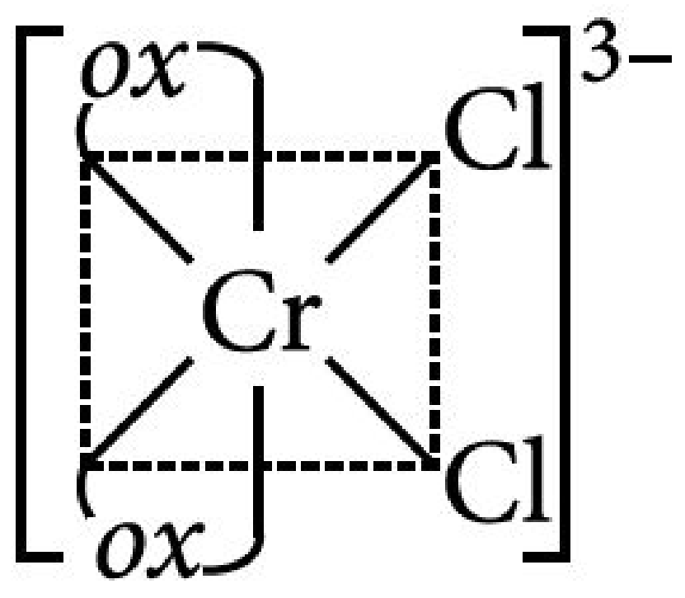
cis-form



Cl
en
Co
en
Cl
+

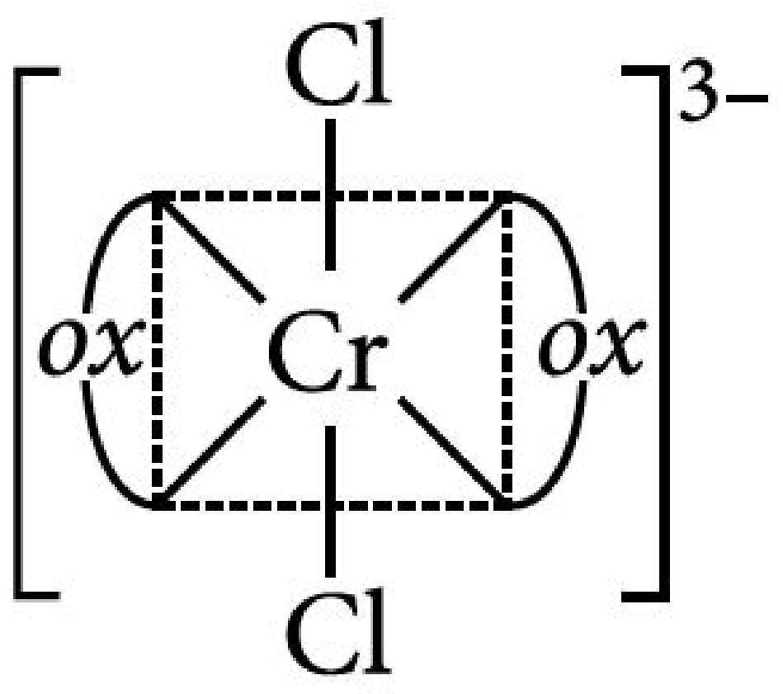
trans-form

$[CrCl_2(C_2O_4)_2]^{3-}$ – $[M(AA)_2B_2]$ type complex, shows geometrical isomerism.



ox
Cl
Cr
Cl
ox
3–

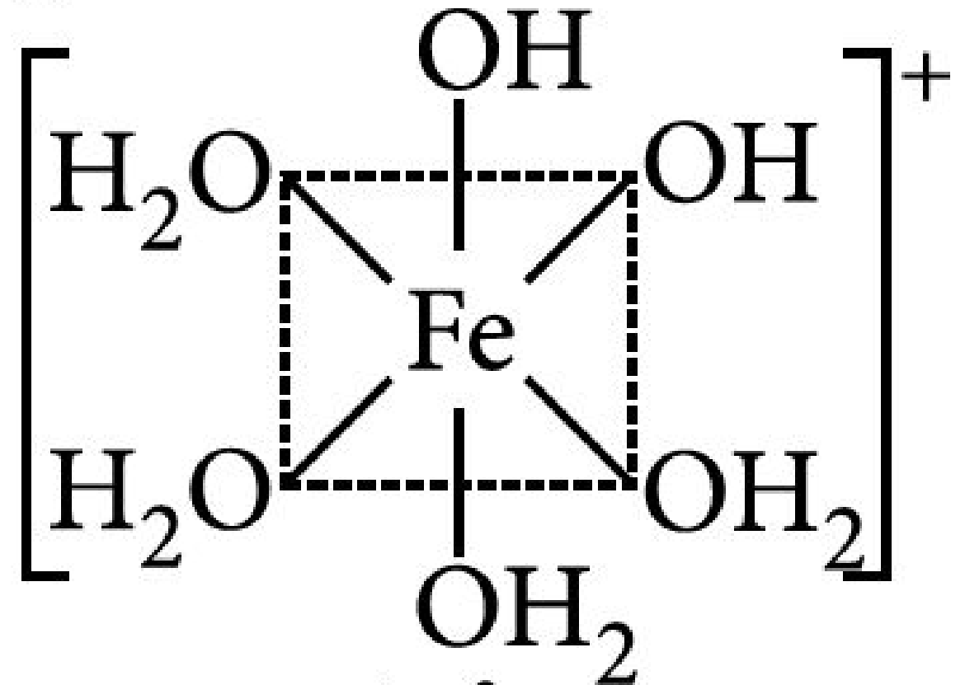
cis-form



Cl
ox
Cr
ox
Cl
3–

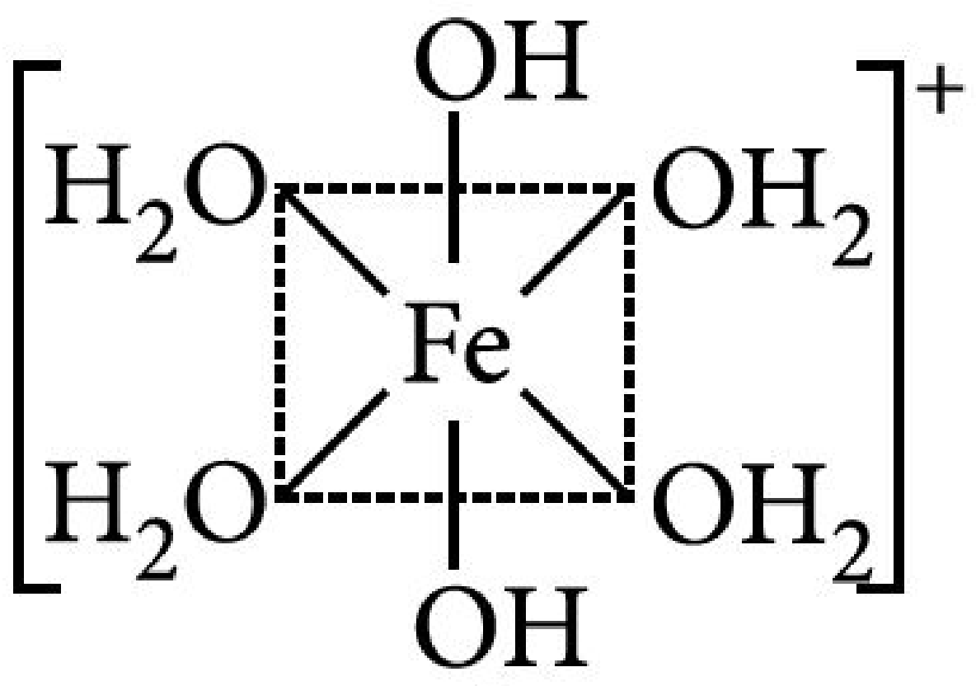
trans-form

$[Fe(H_2O)_4(OH)_2]^+$ – $[MA_4B_2]$ type complex, shows geometrical isomerism.



OH
H2O
OH
Fe
H2O
OH2
OH2
+

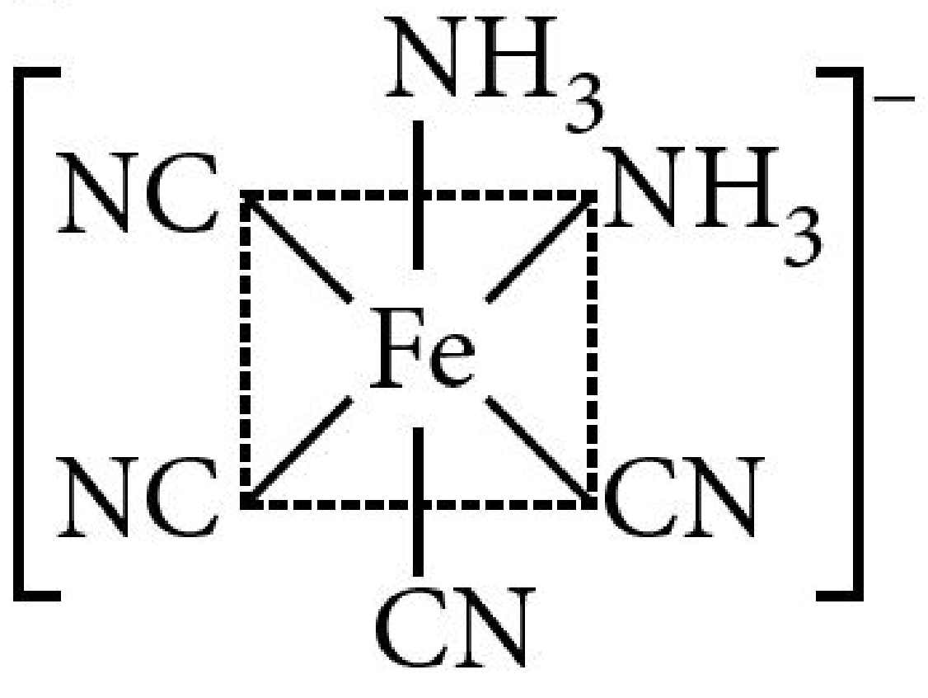
cis-form



OH
H2O
OH2
Fe
H2O
OH2
OH
+

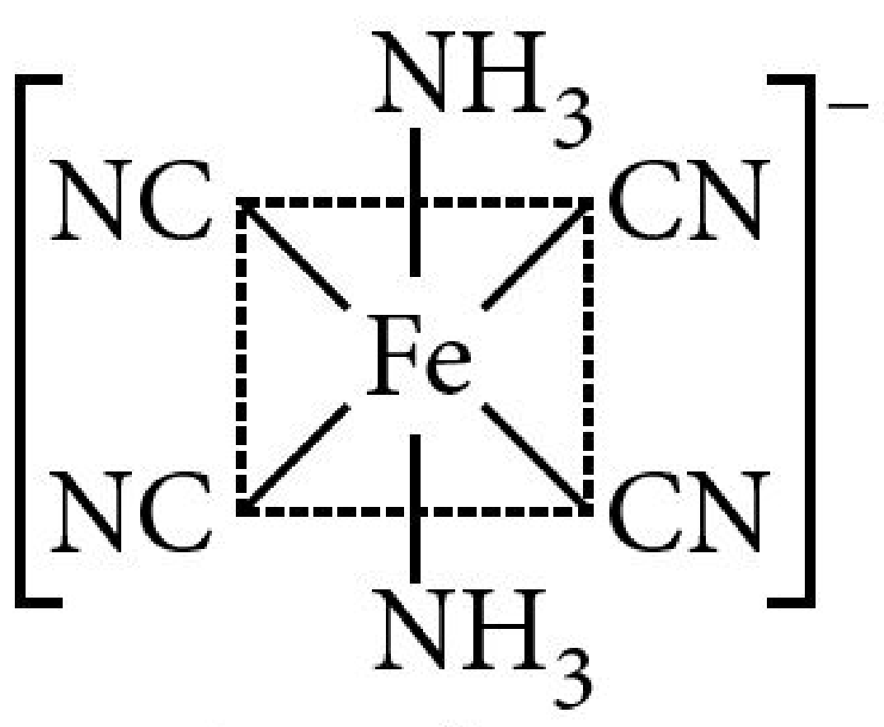
trans-form

$[Fe(NH_3)_2(CN)_4]^-$ – $[MA_4B_2]$ type complex, shows geometrical isomerism.



NH3
NC
NH3
Fe
NC
CN
CN
–

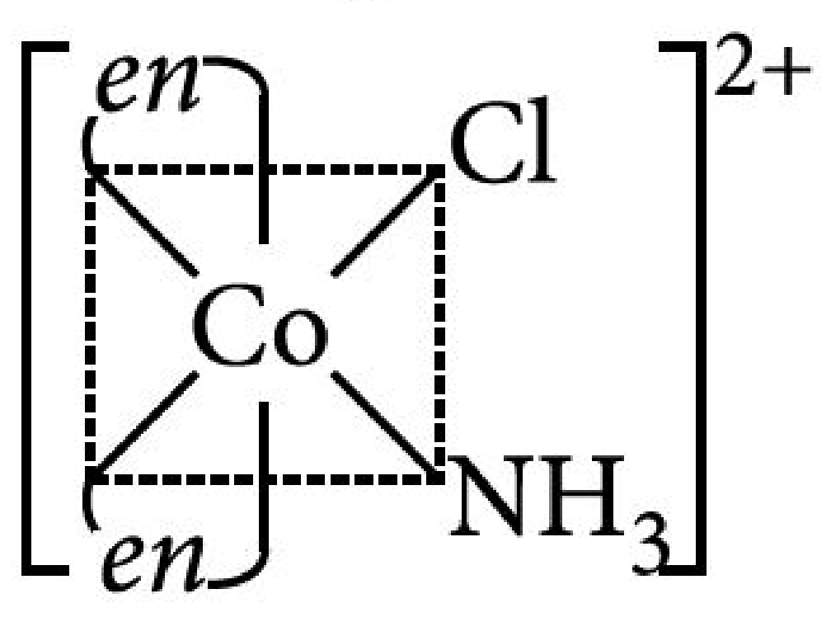
cis-form



NH3
NC
CN
Fe
NC
CN
NH3
–

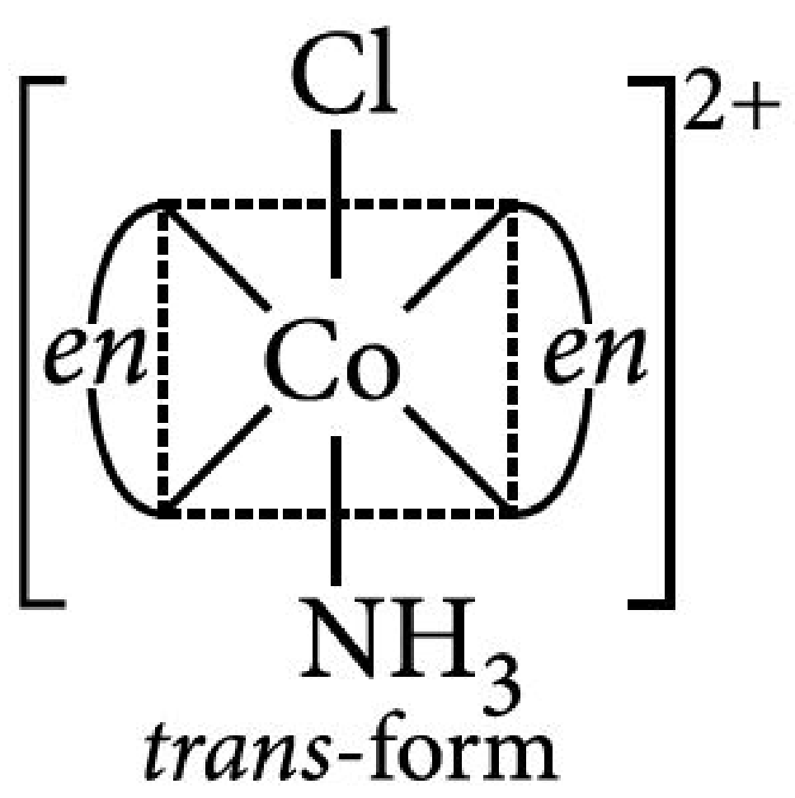
trans-form

$[Co(en)_2(NH_3)Cl]^{2+}$ – $[M(AA)_2BC]$ type complex, shows geometrical isomerism.



en
Cl
Co
NH3
en
2+

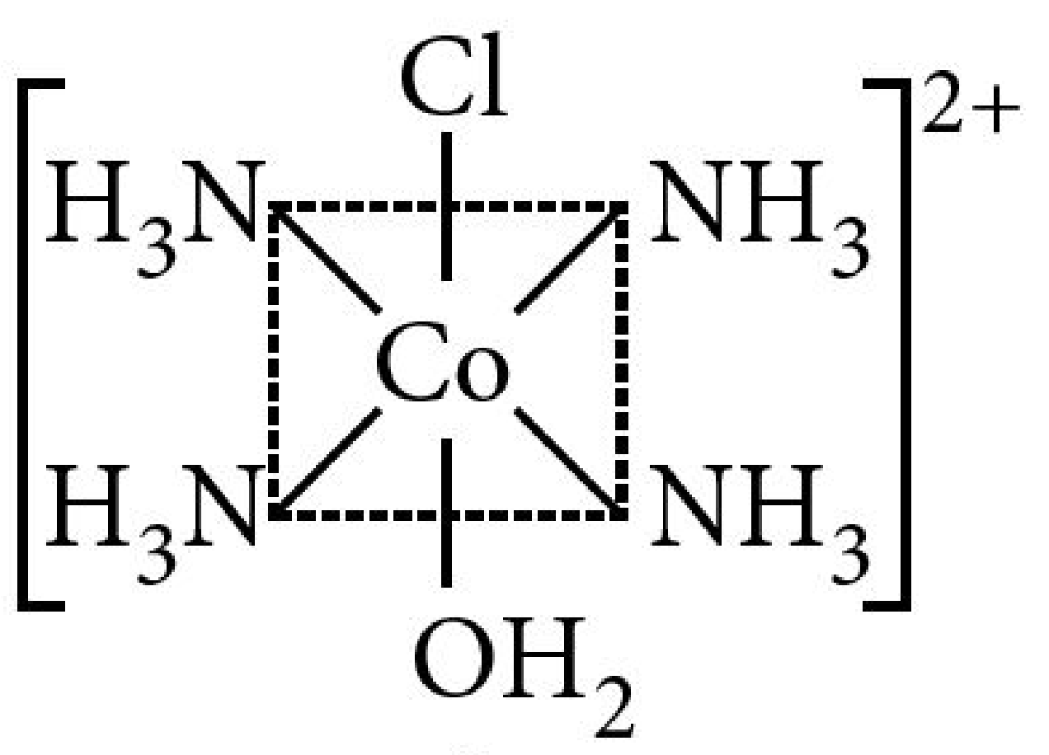
cis-form



Cl
en
Co
en
NH3
2+

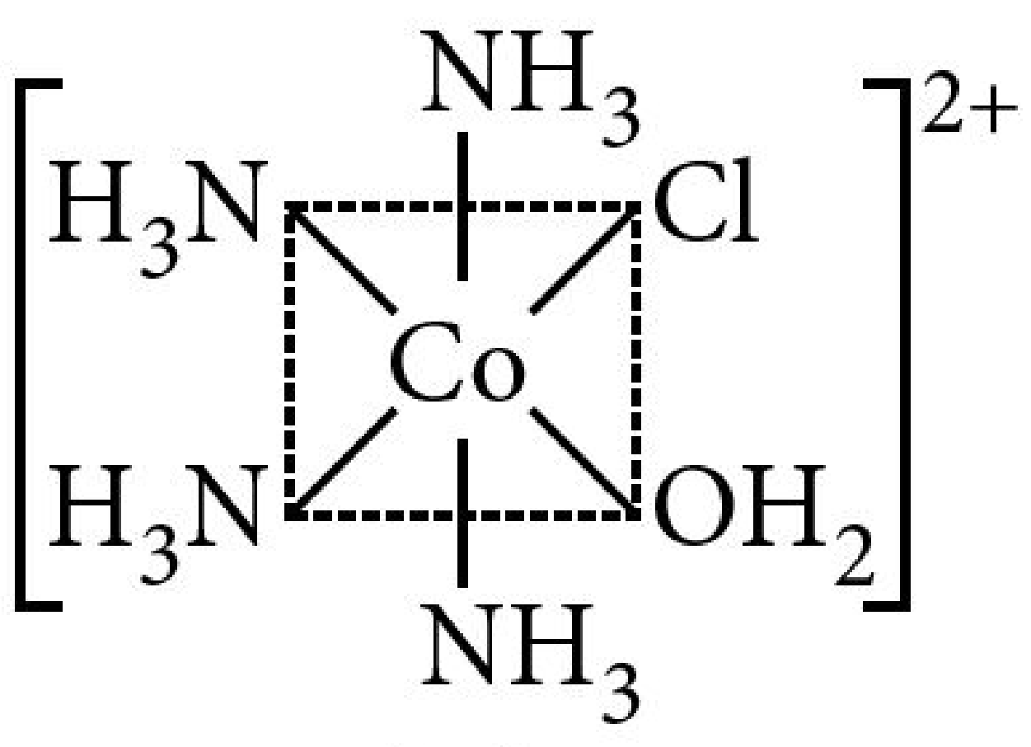
trans-form

$[Co(NH_3)_4(H_2O)Cl]^{2+}$ – $[MA_4BC]$ type complex, shows geometrical isomerism.



Cl
H3N
NH3
Co
H3N
NH3
OH2
2+

trans-form



NH3
H3N
Cl
Co
H3N
OH2
NH3
2+

cis-form

10. (3) : Given : $\Lambda^c_{m(HX)} = \dfrac{\Lambda^c_{m(HY)}}{10}$

$\Lambda^\circ_{m(HX)} = \Lambda^\circ_{m(HY)}$ (∵ $\lambda^\circ_{X^-} \approx \lambda^\circ_{Y^-}$)

$$K_{a(HX)} = \left(\frac{C\alpha^2}{1-\alpha}\right)_{HX}$$

$K_{a(HX)} = 0.01(\alpha_{HX})^2$ (∵ $\alpha <<< 1$) ...(i)

Similarly, $K_{a(HY)} = 0.10(\alpha_{HY})^2$ ...(ii)

On dividing equation (i) by (ii), we get

$$\frac{K_{a(HX)}}{K_{a(HY)}} = \frac{0.01}{0.10}\left(\frac{\alpha_{HX}}{\alpha_{HY}}\right)^2 \quad \text{...(iii)}$$

$$\alpha = \frac{\Lambda^c_m}{\Lambda^\circ_m}$$

$$\frac{\alpha_{HX}}{\alpha_{HY}} = \frac{\left(\Lambda^c_m / \Lambda^\circ_m\right)_{HX}}{\left(\Lambda^c_m / \Lambda^\circ_m\right)_{HY}} = \left(\frac{1}{10}\Lambda^c_{m(HY)}\right) \times \frac{1}{\Lambda^c_{m(HY)}} = \frac{1}{10}$$

Substituting above value in equation (iii),

$$\frac{K_{a(HX)}}{K_{a(HY)}} = \frac{0.01}{0.10}\left(\frac{1}{10}\right)^2 = 1 \times 10^{-3}$$

$\log K_{a(HX)} - \log K_{a(HY)} = \log(1 \times 10^{-3})$

$-\log K_{a(HX)} - (-\log K_{a(HY)}) = -\log(1 \times 10^{-3})$

$pK_{a(HX)} - pK_{a(HY)} = 3$

11. (3) : Let V_1 mL of $NaNO_3$ is mixed with V_2 mL of $Ca(NO_3)_2$.

Millimoles of $NaNO_3$ mixed = $0.2 \times V_1$

Millimoles of $Ca(NO_3)_2$ mixed = $0.1 \times V_2$

∴ Molarity of NO_3^- in mixture

= $[NO_3^-]$ (from $NaNO_3$) + $[NO_3^-]$ (from $Ca(NO_3)_2$)

$$= \frac{0.2 \times V_1}{(V_1 + V_2)} + \frac{0.1 \times 2 \times V_2}{(V_1 + V_2)} = \frac{0.2 \times V_1 + 0.2 \times V_2}{(V_1 + V_2)} \quad \text{...(i)}$$

Molarity of Na^+ and Ca^{2+} ions in mixture

$$= \frac{0.2 \times V_1}{(V_1 + V_2)} + \frac{0.1 \times V_2}{(V_1 + V_2)} = \frac{0.2V_1 + 0.1V_2}{(V_1 + V_2)} \quad \text{...(ii)}$$

Since the concentration of anions is 50% greater than that of cations,

$$\therefore \quad \frac{0.2V_1+0.2V_2}{(V_1+V_2)}=\frac{3}{2}\left[\frac{0.2V_1+0.1V_2}{(V_1+V_2)}\right]$$

$$\Rightarrow \quad \frac{V_1}{V_2}=\frac{x}{y}=\frac{1}{2} \quad \therefore x=1, y=2, \text{ So, } x+y=3$$

12. (100) : $k = A.\, e^{-Ea/RT}$ [Arrhenius equation]

Let the activation energy (E_a) in the absence of catalyst $= x$ kJ mol^{-1}

and activation energy in the presence of catalyst $= (x-20)$ kJ mol^{-1}

Then, at 500 K; $k = A\, e^{-x/500R}$ ...(i)

at 400 K; $k = A\, e^{-(x-20)/400R}$ ...(ii)

Dividing (i) by (ii),

$$1 = \frac{e^{-x/500R}}{e^{-(x-20)/400R}} \text{ or } e^{-x/500R} = e^{-(x-20)/400R}$$

$$\text{or } \frac{x}{500\,R} = \frac{x-20}{400\,R} \text{ or } 4x = 5x - 100$$

or $x = 100$ kJ mol^{-1}

13. (4) : (X) is Microcosmic salt.

$$NH_4Cl + Na_2HPO_4 + 4H_2O \longrightarrow \underset{(X)\text{ Microcosmic salt}}{Na(NH_4)HPO_4.4H_2O} + NaCl$$

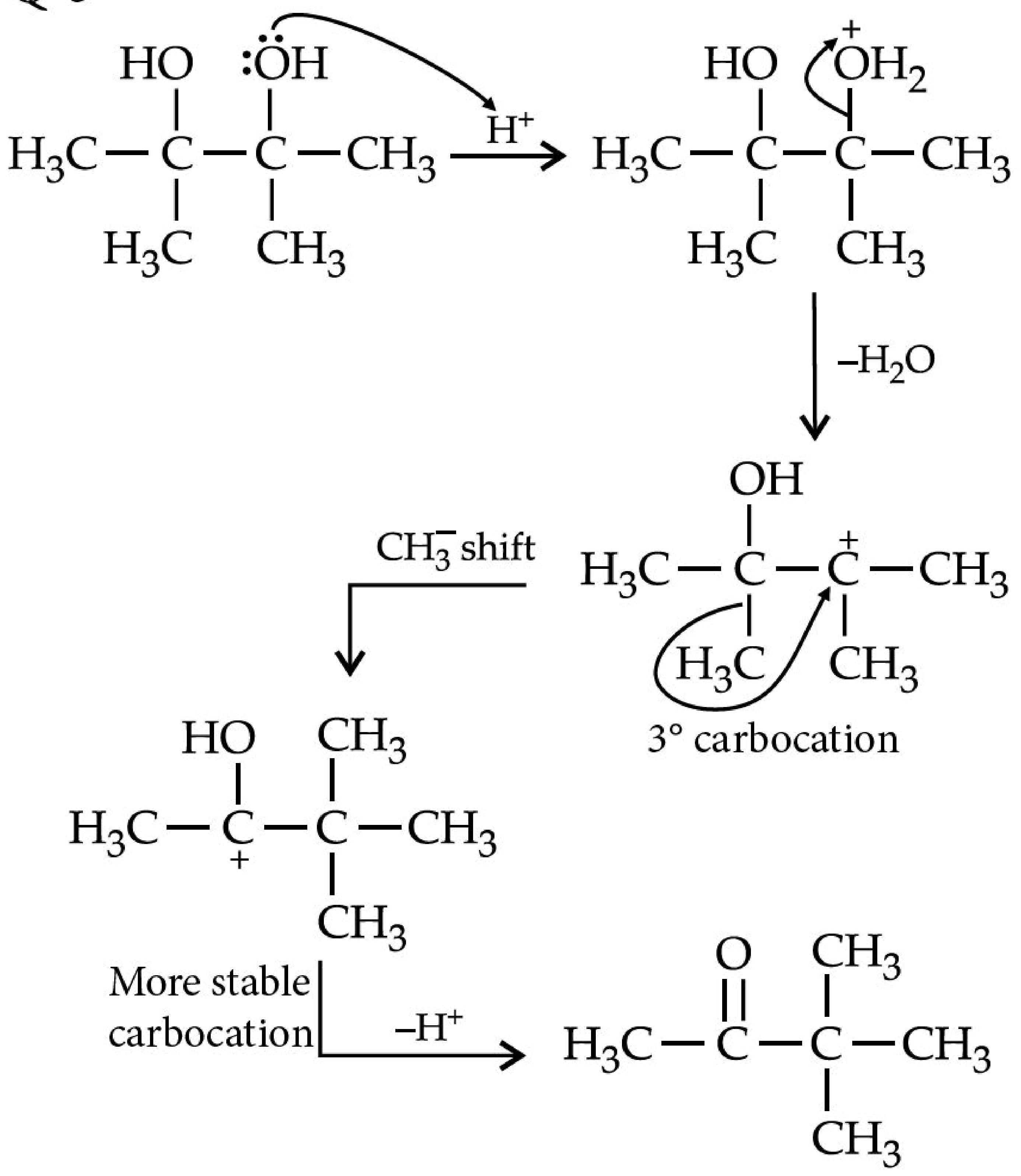
$$Na(NH_4)HPO_4 \xrightarrow{\Delta} \underset{\text{Sodium metaphosphate}}{NaPO_3} + NH_3 + H_2O$$

$$NaPO_3 + CuO \longrightarrow \underset{\text{Blue mass}}{NaCuPO_4}$$

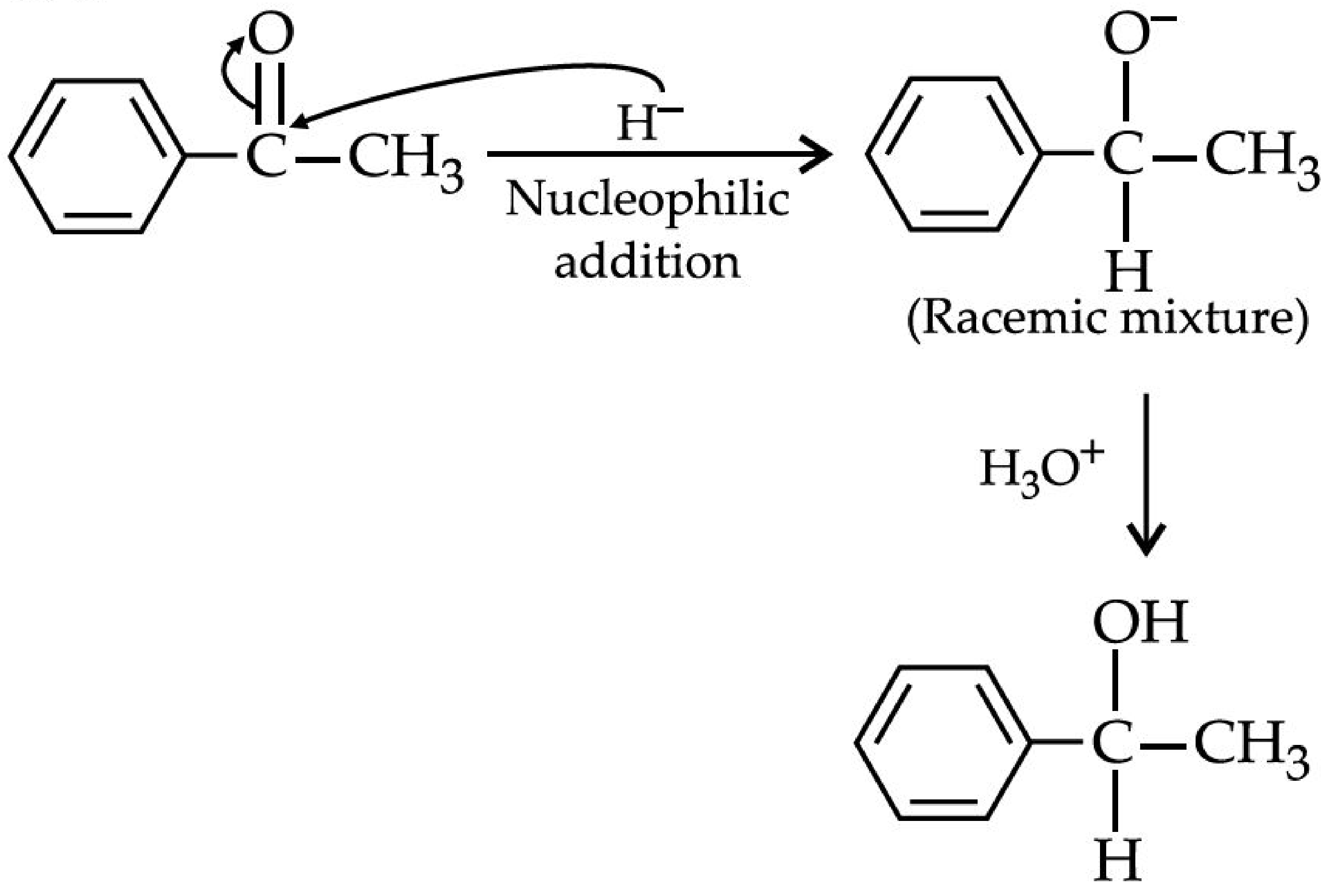
Thus (X), , Microcosmic salt has 4 molecules of water.

14. (b) : P-4 - Diazo-coupling reaction.

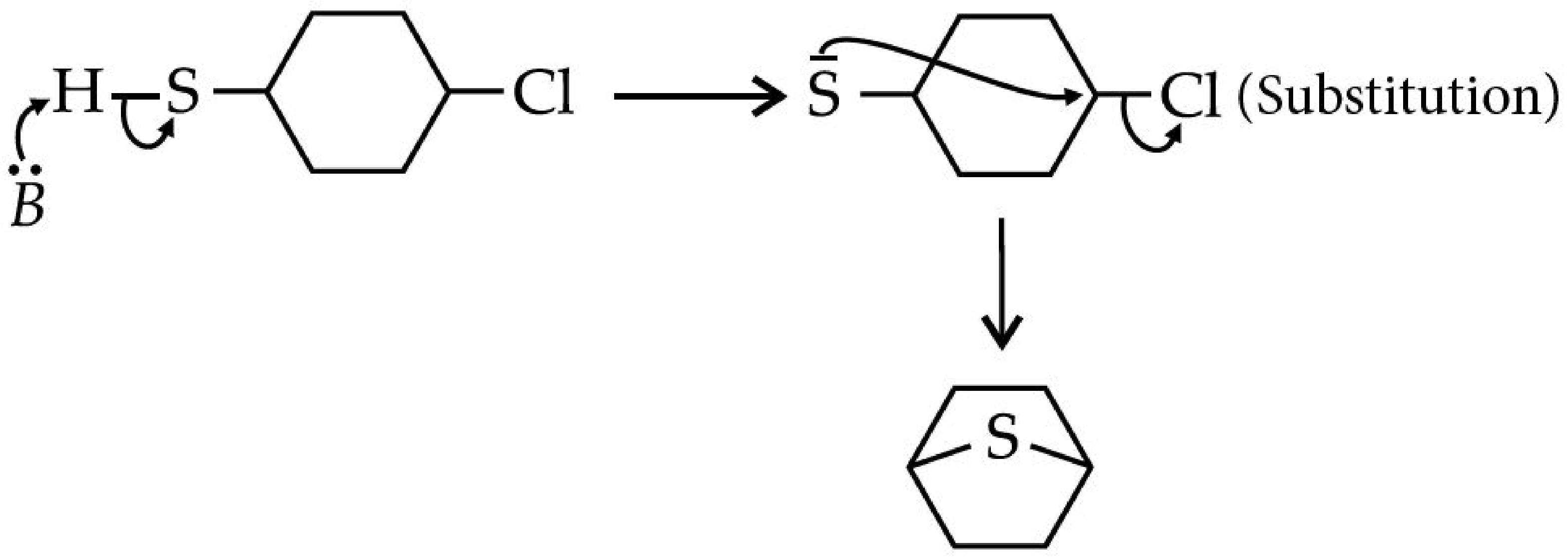
Q-5


H⁺
–H₂O
CH₃⁻ shift
3° carbocation
More stable carbocation
–H⁺

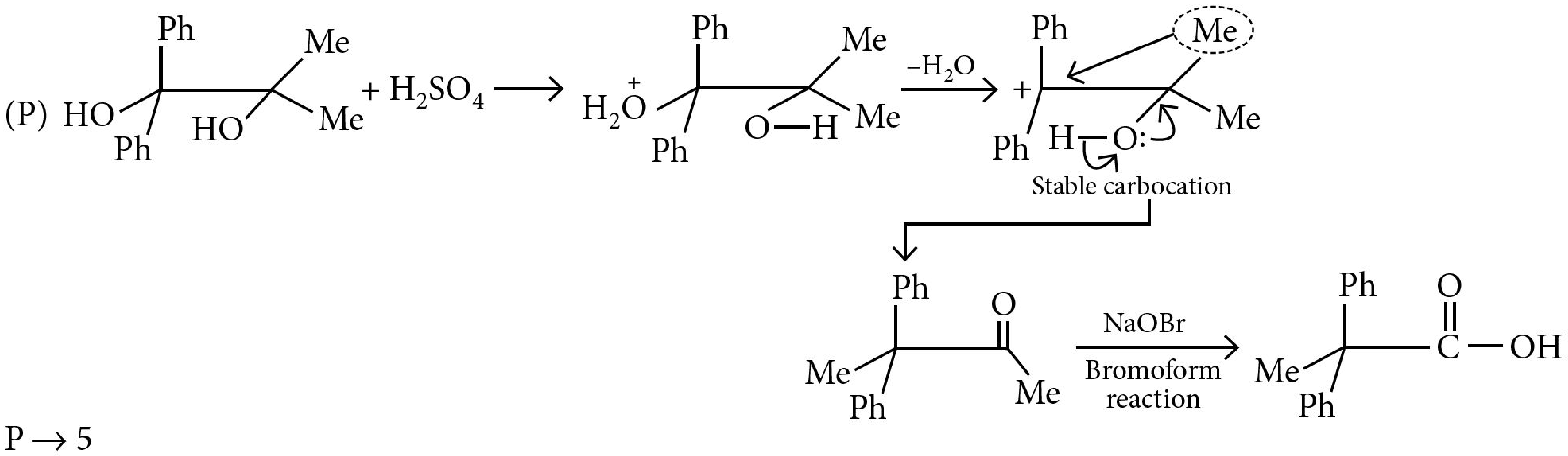
R-1


H⁻
Nucleophilic addition
(Racemic mixture)
H₃O⁺

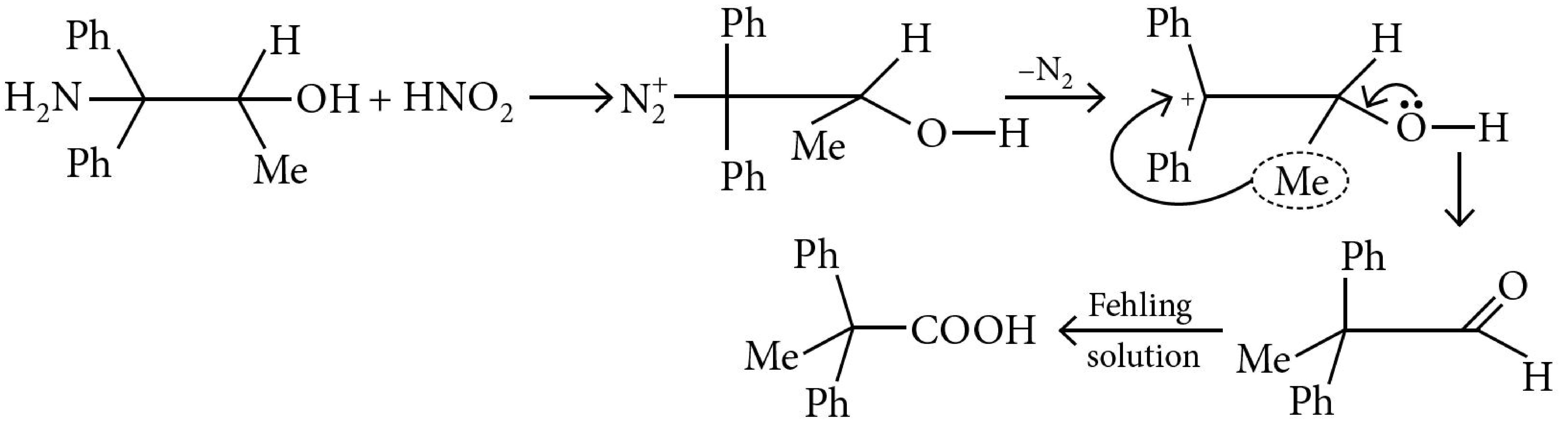
S-3


(Substitution)

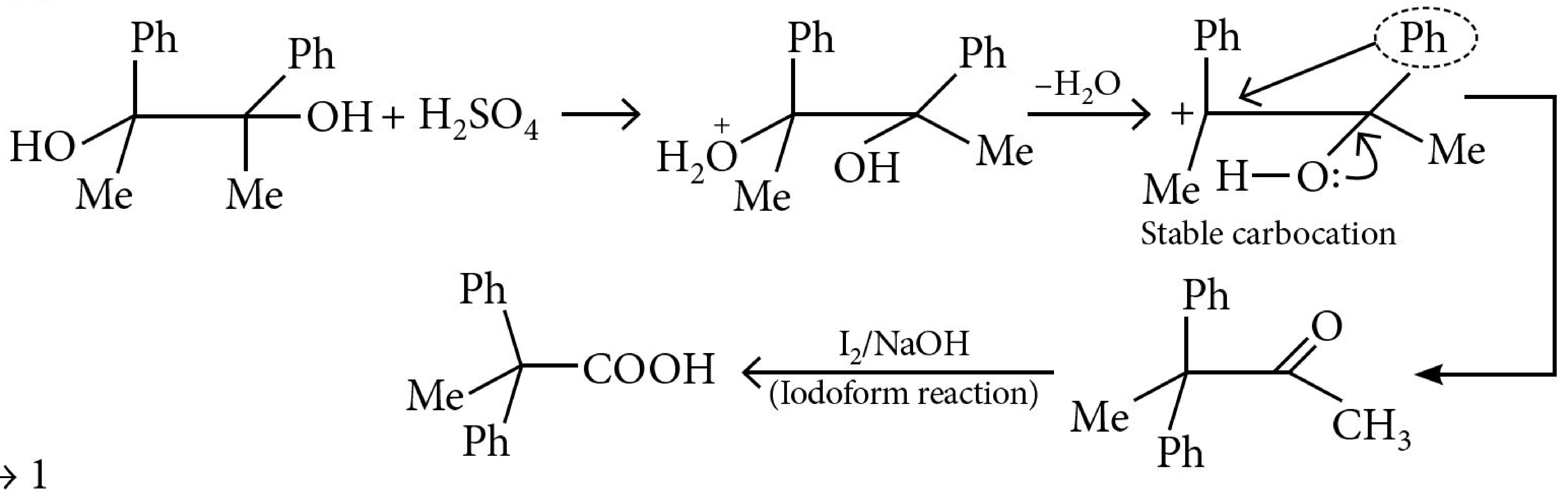
15. (d) :


(P)
+ H₂SO₄
–H₂O
Stable carbocation
NaOBr
Bromoform reaction

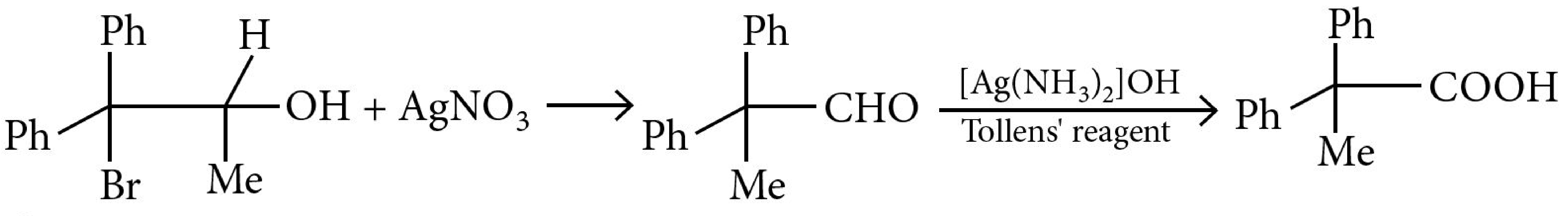
P → 5

(Q) 

Q → 3

(R) 

R → 1

(S) 

S → 2

16. (d) : (P) $[CH_3COOH]_{old} = \frac{20\times0.1-10\times0.1}{30} = \frac{1}{30}$

$[CH_3COO^-]_{new} = \frac{1}{30}$

Buffer with [Salt] = [Acid]
pH does not change on dilution (P) → (1)

(Q) $[CH_3COO^-]_{old} = \frac{20\times0.1}{40} = \frac{2}{40}$

$[CH_3COO^-]_{new} = \frac{2}{80}$

$\underset{c}{CH_3COO^-} + H_2O \longrightarrow \underset{x}{CH_3COOH} + \underset{x}{OH^-}$

$K_h = \frac{x^2}{c} = \frac{[OH^-]^2_{old}}{2/40} = \frac{[OH^-]^2_{new}}{2/80}$

or, $[OH^-]^2_{new} = \frac{[OH^-]^2_{old}}{2}$ or, $[OH^-]_{new} = \frac{[OH^-]_{old}}{\sqrt{2}}$

$\therefore\ [H^+]_{new} = \sqrt{2}[H^+]_{old}$

(Q) → (5)

(R) $[NH_4^+]_{old} = \frac{20\times0.1}{40} = \frac{2}{40}$, $[NH_4^+]_{new} = \frac{2}{80}$

$\underset{c}{NH_4^+} + H_2O \rightleftharpoons \underset{y}{NH_4OH} + \underset{y}{H^+}$

$K_h = \frac{y^2}{c} = \frac{[H^+]^2_{old}}{2/40} = \frac{[H^+_{new}]^2}{2/80}$

or $[H^+_{new}]^2 = \frac{[H^+_{old}]^2}{2} \Rightarrow [H^+_{new}] = \frac{[H^+]_{old}}{\sqrt{2}}$

(R) → (4)

(S) For a saturated solution, $Ni(OH)_2 \rightleftharpoons \underset{s}{Ni^{2+}} + \underset{2s}{2OH^-}$

$K_{sp} = s \times (2s)^2 = 4s^3$

$s = [OH^-] = \sqrt[3]{\frac{K_{sp}}{4}}$

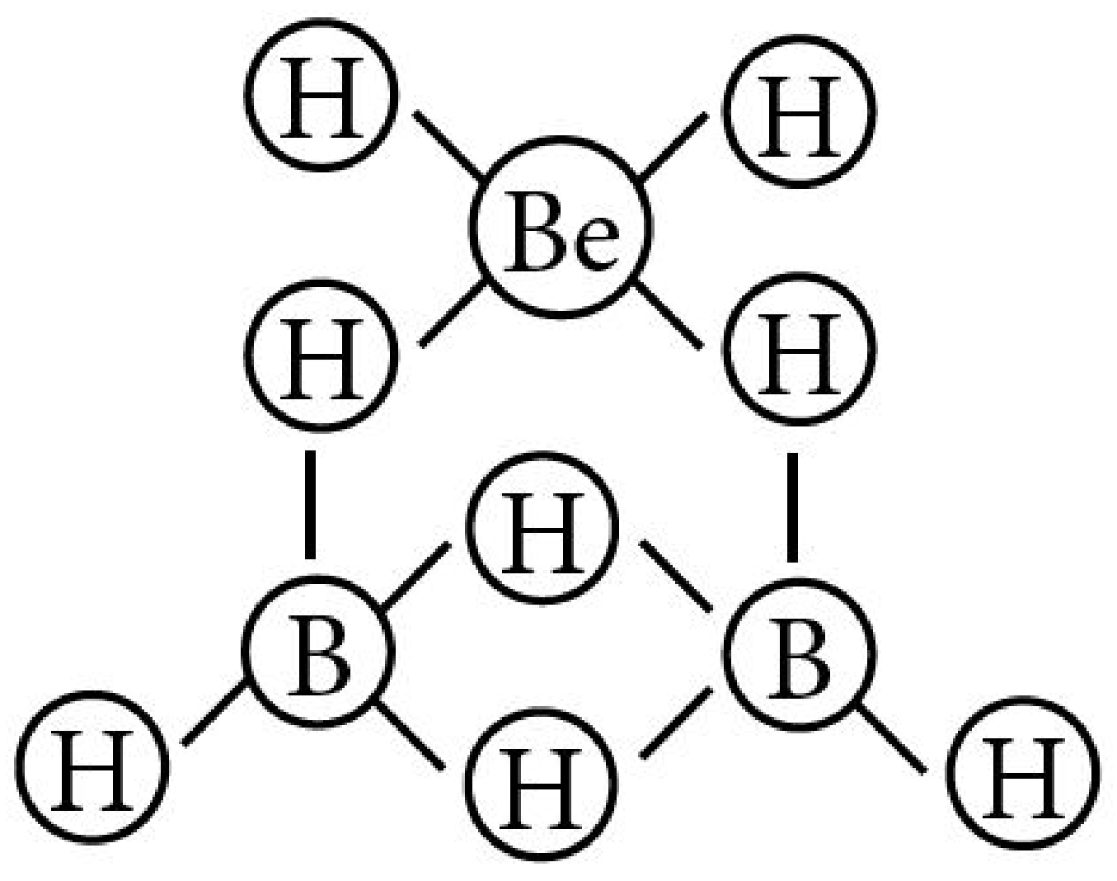
Irrespective of volume of solution, $[H^+]$ remains constant.

(S) → (1)

17. (d)

PAPER-II

1. (d) : Bond on the given information, the most appropriate structure for XY_2H_8 is :



Thus *X* is beryllium (Be) and *Y* is boron (B).

2. (c) : Magnetic moment, $\mu = \sqrt{n(n+2)}$ B.M.
When *n* = 1, μ = 1.73 B.M. ~ 1.8 B.M. (Given)

Cu(29) : $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^{10}, 4s^1$

Cu has one unpaired electron. Hence, the metal '*A*' would be Cu.

$$\underset{(A)}{\text{Cu}} + H_2SO_{4(\text{dil.})} + \frac{1}{2}O_2 \longrightarrow \underset{(B)}{CuSO_4} + H_2O$$

$$\underset{(B)}{2CuSO_4} + \underset{(C)}{4KI} \longrightarrow \underset{(D)}{Cu_2I_2} + I_2 + 2K_2SO_4$$

3. (c) : $\frac{x}{m} = k \cdot P^{1/n}$

$$\log\frac{x}{m} = \log k + \frac{1}{n}\log P$$

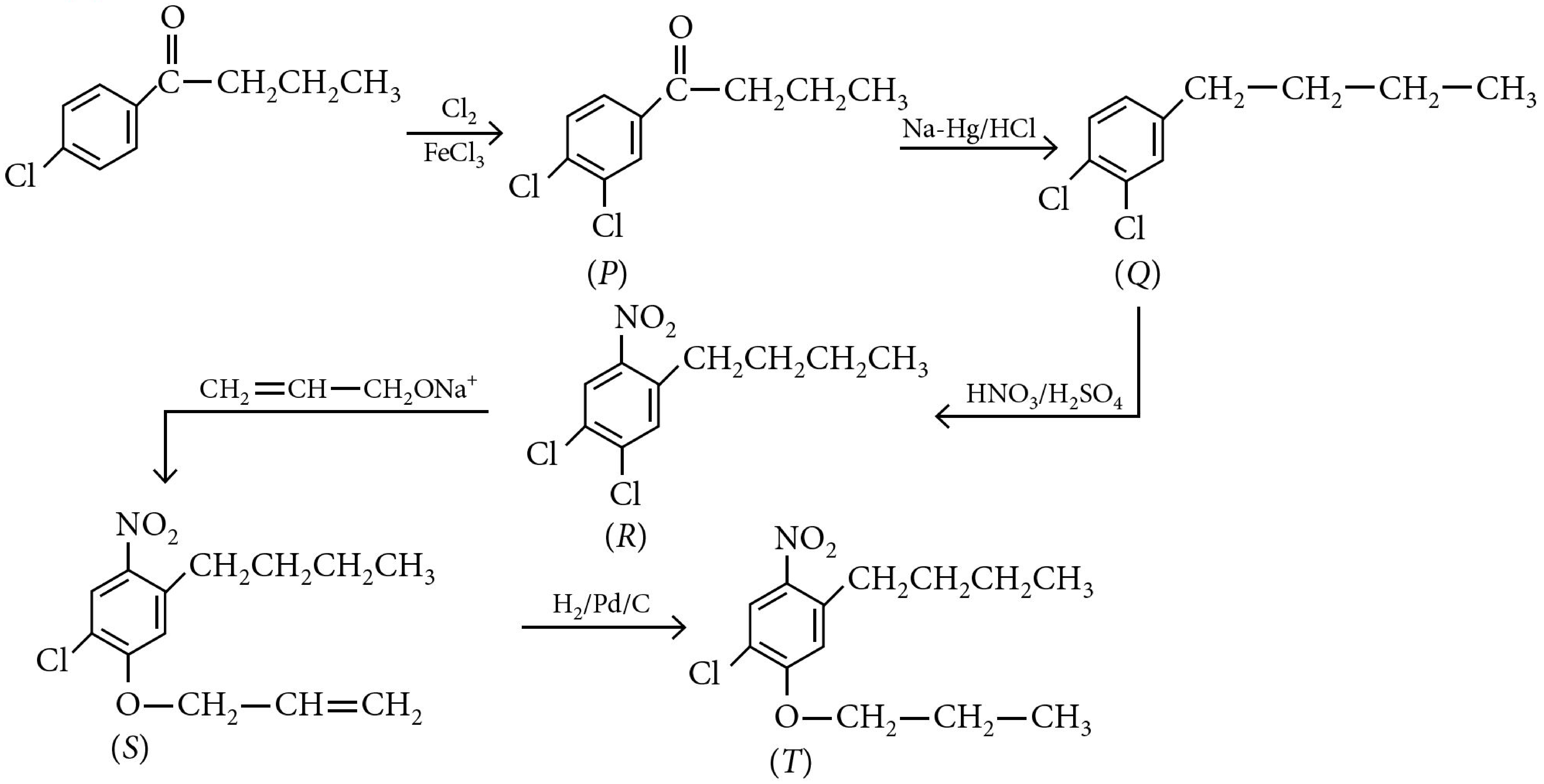
Plot of $\log\frac{x}{m}$ *vs* $\log P$ is a straight line, with slope = $\frac{1}{n}$ and intercept $\log k$.

Since $\log k = 0.699$, hence $k = 5$

Slope = $\frac{1}{n}$ = tan 45° = 1, hence $n = 1$, $P = 0.5$ atm

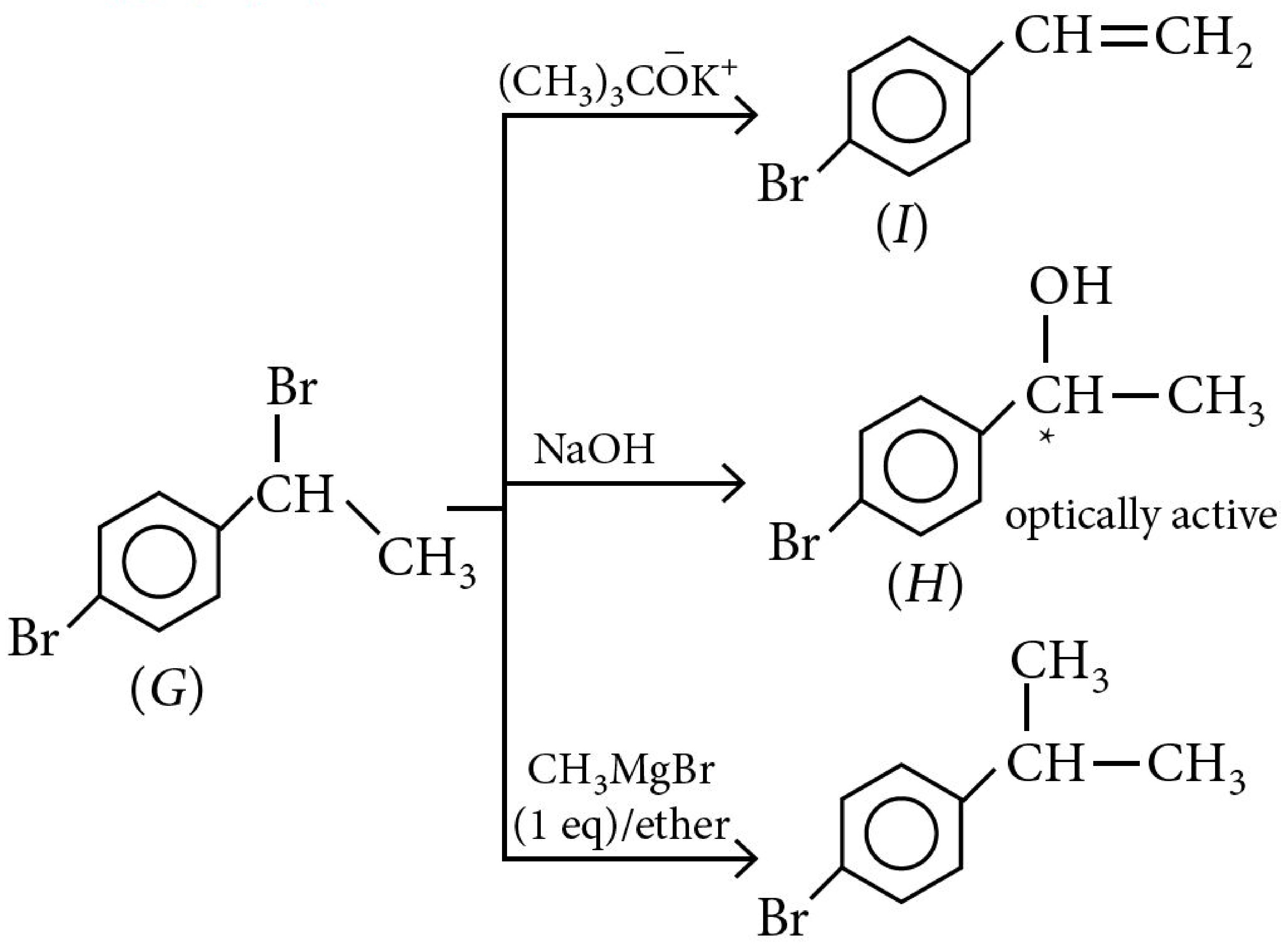
Thus, $\frac{x}{m} = 5 \times (0.5)^1 = 2.5$ g per gram of adsorbent

4. (b) :



O
C—CH₂CH₂CH₃
Cl
Cl₂
FeCl₃
Na-Hg/HCl
CH₂—CH₂—CH₂—CH₃
Cl
Cl
(P)
(Q)
HNO₃/H₂SO₄
NO₂
CH₂CH₂CH₂CH₃
CH₂=CH—CH₂ONa⁺
(R)
H₂/Pd/C
O—CH₂—CH=CH₂
(S)
O—CH₂—CH₂—CH₃
(T)

5. (a, b, c, d) :



(CH₃)₃CŌK⁺
CH=CH₂
Br
(I)
OH
CH—CH₃
*
optically active
NaOH
(H)
Br
CH
CH₃
(G)
CH₃MgBr
(1 eq)/ether
CH₃
CH—CH₃

6. (a, b) : (a) Victor Meyer's method is used to determine molecular mass of volatile organic compound. Dumas method is used to determine percentage of N. The molecular mass of non-volatile compound is determined by depression in freezing point or by elevation in boiling point method.

(b) Indicates the presence of Br.

7. (a, b, c) : $B_2H_6 + 2N(CH_3)_3 \rightarrow 2BH_3{\cdot}N(CH_3)_3$

$B_2H_6 + 2NH_3 \rightarrow [BH_2(NH_3)_2]^+ + [BH_4]^-$

$B_2H_6 + 2CO \rightarrow 2BH_3 \cdot CO$

8. (2) : At temperature T, $PV = RT$

When temperature is increased by 1°, at constant pressure. Let the volume increases by ΔV.

$\therefore \quad P(V + \Delta V) = R(T + 1)$

or $\quad PV + P\Delta V = RT + R$

$\because \quad PV = RT \qquad \therefore P\Delta V = R$

i.e., Work done = R = 2 cal mol^{-1} K^{-1}

9. (4) : $\frac{P_{H_2O}}{P_{C_6H_5NO_2}} = \frac{W_{H_2O}}{M_{H_2O}} \times \frac{M_{C_6H_5NO_2}}{W_{C_6H_5NO_2}}$

P_{H_2O} = 733 mm Hg, $P_{C_6H_5NO_2}$ = 27 mm Hg,

$M_{H_2O} = 18 \text{ g mol}^{-1}$, $M_{C_6H_5NO_2} = 123 \text{ g mol}^{-1}$

$$\frac{18}{123} \times \frac{733}{27} = \frac{W_{H_2O}}{W_{C_6H_5NO_2}} = 3.97$$

10. (2) : (1)(*X*), (C_5H_8O) does not react with Lucas reagent appreciably at room temperature but gives precipitate with ammoniacal $AgNO_3$,and thus, (*X*) has terminal alkyne linkage as well as primary alcoholic group.
(2) (*X*) on hydrogenation and then reacting with HI gives *n*-pentane and thus, (*X*) is a straight chain compound.
(3) Keeping in view of the above facts (*X*) may be

$$\underset{\text{Pent-4-yn-1-ol}}{\underset{(X)}{HOCH_2-CH_2-CH_2-C\equiv CH}}$$

(4) Its reaction with MeMgBr gives CH_4. (It has two acidic or active H atoms) and thus, 1 mole of (*X*) will give two moles of CH_4.

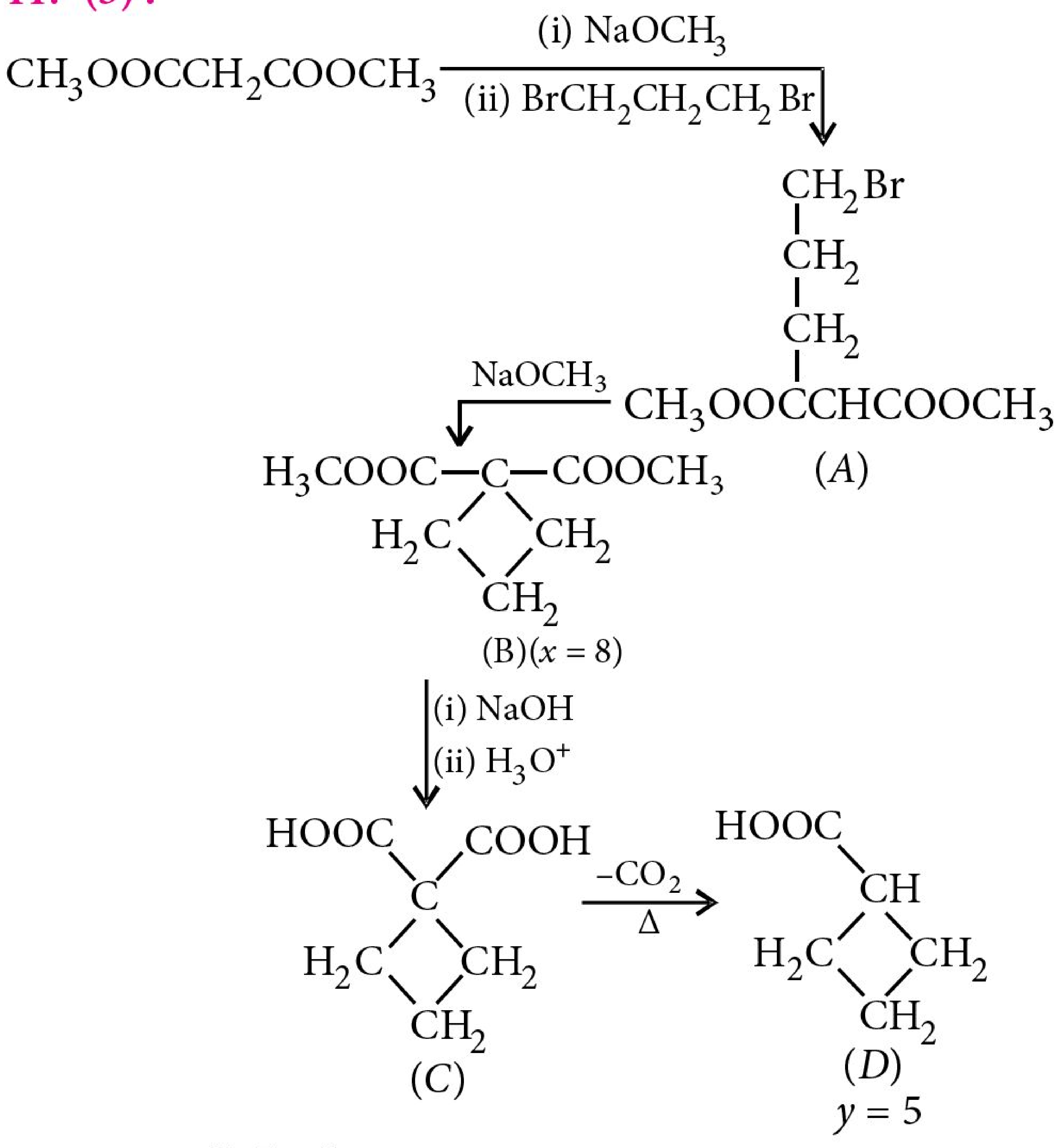
$$OHCH_2-CH_2-CH_2-C\equiv CH + 2CH_3MgBr \rightarrow 2CH_4$$

$\because$ 84 g(*X*) gives 2 × 22.4 litre CH_4

$\therefore$ 0.42 g (*X*) will give $\dfrac{2 \times 22.4 \times 0.42}{84} = 224 \text{ mL } CH_4$

Thus compound (*X*) has 2 acidic H-atoms.

11. (3) :



$\therefore$ $x - y = 8 - 5 = 3$

12. (4) : The ionisation energies provide an indication about the number of valence electrons in an atom.
In this case, *X* has $IE_5 >> IE_4 > IE_3 > IE_2 > IE_1$.
The large jump between IE_4 and IE_5 shows that it has four valence electrons.

13. (3)

14. (0.19) : The increase in mass at the cathode is due to deposition of Cu($Cu^{2+} + 2e^- \rightarrow Cu$). The loss in mass of anode is due to loss of Cu and Fe because of their oxidation. These two are active metals and will oxidise as
$Cu \rightarrow Cu^{2+} + 2e^-$
$Fe \rightarrow Fe^{2+} + 2e^-$
and loss of Ag and Au to fall in anode mud.
Thus, gain in weight at cathode is due to deposition of Cu = 22.011 g

$\therefore$ Moles of Cu deposited at cathode $= \dfrac{22.011}{63.5}$
$= 0.3466$

Equivalent of Cu and Fe dissolved at anode

$$= \frac{I \cdot t}{96500} = \frac{140 \times 482.5}{96500} = 0.70$$

$\therefore$ Moles of Cu and Fe dissolved at anode $= \dfrac{0.70}{2} = 0.35$

(both Cu and Fe are bivalent losing two electrons).
Moles of Fe dissolved at anode = 0.3500 – 0.3466
= 0.0034

$\therefore$ Wt. of Fe dissolved at anode = 0.0034 × 56 = 0.190 g.

15. (98.88) : Anode weight loss of 22.260 g contains 22.011 g Cu

$\therefore$ % Cu originally present $= \dfrac{22.011}{22.26} \times 100 = 98.88\%$.

16. (3) : $PbCO_3 \rightleftharpoons \underset{x}{Pb^{2+}} + \underset{x+y}{CO_3^{2-}}$

$MgCO_3 \rightleftharpoons \underset{y}{Mg^{2+}} + \underset{x+y}{CO_3^{2-}}$

(Since both are present in same solution)

$$\therefore \quad \frac{K_{sp}(PbCO_3)}{K_{sp}(MgCO_3)} = \frac{x}{y} \quad \text{or} \quad \frac{x}{y} = \frac{1.5 \times 10^{-15}}{1 \times 10^{-15}} \quad \text{or } x = 1.5y$$

Now, $x(x + y) = 1.5 \times 10^{-15}$

or, $1.5y(1.5y + y) = 1.5 \times 10^{-15} \Rightarrow y \approx 2 \times 10^{-8}$

$\therefore$ $x = 1.5 \times 2 \times 10^{-8} = 3.0 \times 10^{-8}$ M

17. (6.40)

◆◆

UNSCRAMBLED WORDS

APRIL 2025

1-d-AROMATISATION
2-a-PHOSPHORESCENCE
3-e-TENNESSINE
4-b-AMPHIPATHIC
5-f-PROTEASE
6-c-DILATOMETER
7-i-CYCLOHEXYL
8-g-LANTHANUM
9-j-TURPENTINE
10-h-OZONIDES

Winners : *Vimal, Neeraj*

CUET (UG)

Between
8th May to
1st June 2025

PRACTICE PAPER 2025

Section II of CUET (UG) is domain specific. In this section of Chemistry all 50 questions to be attempted. All questions are compulsory.

Time Allowed : 60 Minutes

Maximum Marks : 250

1. Raoult's Law is obeyed by a binary liquid solution when
(a) the forces of attractions between like molecules are greater than those between unlike molecules
(b) the forces of attractions between like molecules are smaller than those between unlike molecules
(c) the forces of attractions between like molecules are more or less identical with those between unlike molecules
(d) the volume occupied by unlike molecules are different.

2. When $CH_3CHClCH_2CH_3$ is treated with alcoholic KOH, the major product is
(a) $CH_3—CH═CH—CH_3$
(b) $CH_2═CH—CH_2—CH_3$
(c) $CH_3—CHOH—CH_2—CH_3$
(d) $CH_3—CH_2—CH_2—CH_3$

3. Which of the following statements is correct? For 0.1 M solution of each
(a) osmotic pressure of NaCl and Na_2SO_4 solution will be same
(b) osmotic pressure of NaCl solution will be more than Na_2SO_4 solution
(c) osmotic pressure of Na_2SO_4 solution will be more than NaCl solution
(d) osmotic pressure of Na_2SO_4 could be less or more than that of NaCl solution.

4. Increasing order of acid strength among *p*-methoxyphenol, *p*-methylphenol and *p*-nitrophenol is
(a) *p*-Nitrophenol, *p*-Methoxyphenol, *p*-Methylphenol
(b) *p*-Methylphenol, *p*-Methoxyphenol, *p*-Nitrophenol
(c) *p*-Nitrophenol, *p*-Methylphenol, *p*-Methoxyphenol
(d) *p*-Methoxyphenol, *p*-Methylphenol, *p*-Nitrophenol.

5. The experimental data for the reaction $2x + y_2 \rightarrow 2xy$ are as follows.

$[x]$ (mol L^{-1})	$[y_2]$ (mol L^{-1})	Rate (mol L^{-1} s^{-1})
0.50	0.50	1.6×10^{-4}
0.50	1.0	3.2×10^{-4}
1.00	1.0	3.2×10^{-4}

What is the probable expression of rate?
(a) $k[x]$
(b) $k[x]^2[y_2]$
(c) $k[x][y_2]$
(d) $k[y_2]$

6. Cannizzaro reaction is not given by
(a) acetaldehyde
(b) formaldehyde
(c) benzaldehyde
(d) trimethylacetaldehyde.

7. Amongst $[Ni(CO)_4]$, $[Ni(CN)_4]^{2-}$ and $[NiCl_4]^{2-}$,
(a) $[Ni(CO)_4]$ and $[NiCl_4]^{2-}$ are diamagnetic $[Ni(CN)_4]^{2-}$ is paramagnetic
(b) $[NiCl_4]^{2-}$ and $[Ni(CN)_4]^{2-}$ are diamagnetic and $[Ni(CO)_4]$ is paramagnetic
(c) $[Ni(CO)_4]$ and $[Ni(CN)_4]^{2-}$ are diamagnetic and $[NiCl_4]^{2-}$ is paramagnetic.
(d) $[Ni(CO)_4]$ is diamagnetic and $[NiCl_4]^{2-}$ and $[Ni(CN)_4]^{2-}$ are paramagnetic.

8. The Henry's law constant for the solubility of N_2 gas in water at 298 K is 1.0×10^5 atm. The mole fraction of N_2 in air is 0.8. The number of moles of N_2 from air dissolved in 10 moles of water at 298 K and 5 atm pressure is
(a) 4.0×10^{-4}
(b) 4.0×10^{-5}
(c) 5.0×10^{-4}
(d) 4.0×10^{-6}

9. Which of the following molecules form a zwitter ion?

(a) CH_3COOCH_3 (b) H_2NCH_2COOH
(c) $CH_3COC_2H_5$ (d) CH_3CH_2COOH

10. Match the column I with column II and mark the appropriate choice.

Column I		Column II	
(A)	$\Delta H_{mix} = 0, \Delta V_{mix} = 0$	(i)	Non-ideal solution
(B)	$\Delta H_{mix} \neq 0, \Delta V_{mix} \neq 0$	(ii)	Positive deviation
(C)	$\Delta H_{mix} < 0, \Delta V_{mix} < 0$	(iii)	Ideal solution
(D)	$\Delta H_{mix} > 0, \Delta V_{mix} > 0$	(iv)	Negative deviation

(a) (A) – (i), (B) – (iii), (C) – (ii), (D) – (iv)
(b) (A) – (iii), (B) – (i), (C) – (iv), (D) – (ii)
(c) (A) – (ii), (B) – (iii), (C) – (iv), (D) – (i)
(d) (A) – (iii), (B) – (ii), (C) – (i), (D) – (iv)

11. The lanthanide contraction is responsible for the fact that

(a) Zr and Y have about the same radius
(b) Zr and Nb have similar oxidation state
(c) Zr and Hf have about the same radius
(d) Zr and Zn have the same oxidation state.

12. The half-life period for a first order reaction is 15 min. The time required for the concentration of the reactant to change from 0.12 M to 0.08 M is

(a) 18 min (b) 8.77 min
(c) 5.67 min (d) 11 min

13. Which of the following reactions is not correctly matched?

(a) $2C_2H_5Br + 2Na \xrightarrow{\text{dry ether}} C_4H_{10} + 2NaBr$: Wurtz reaction
(b) $CH_3Br + AgF \longrightarrow CH_3F + AgBr$: Etard reaction
(c) $C_6H_5Br + 2Na + BrC_2H_5 \xrightarrow{\text{dry ether}} C_6H_5C_2H_5 + 2NaBr$: Wurtz–Fittig reaction
(d) $2C_6H_5Br + 2Na \xrightarrow{\text{dry ether}} C_6H_5 - C_6H_5 + 2NaBr$: Fittig reaction

14. An antifreeze solution is prepared from 222.6 g of ethylene glycol, $C_2H_4(OH)_2$ and 200 g of water. If the density of the solution is 1.072 g mL^{-1}, then what shall be the molarity of the solution?

(a) 0.91 M (b) 17.95 M
(c) 9.11 M (d) 4.56 M

15. Match Column I with Column II and select the correct option.

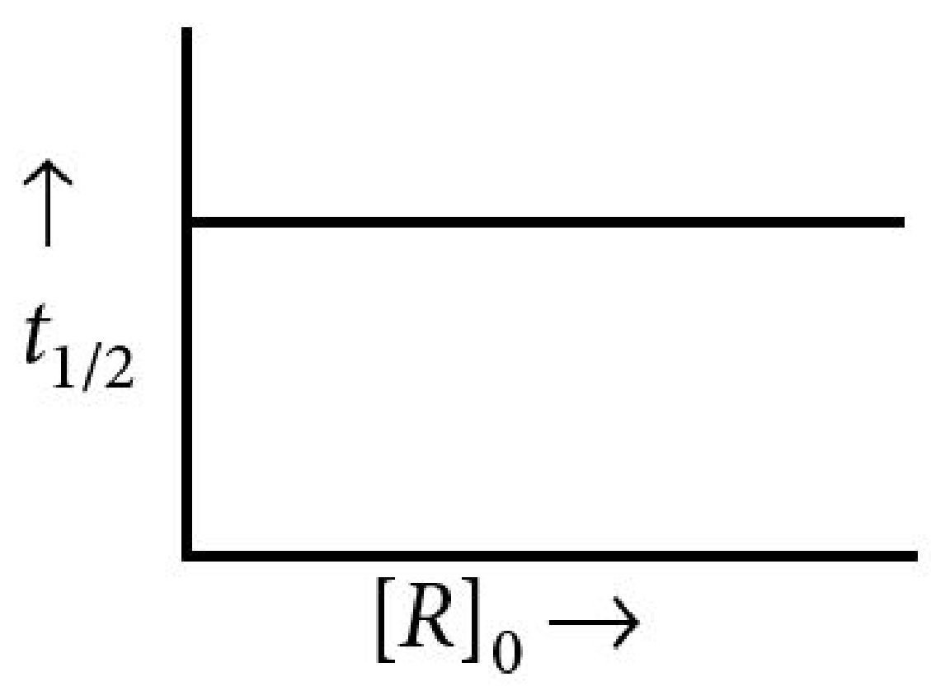
Column I		Column II	
(A)	Lechlanche cell	(i)	Cell reaction, $2H_2 + O_2 \longrightarrow 2H_2O$
(B)	Ni–Cd cell	(ii)	Does not involve any ion in solution and is used in hearing aids.
(C)	Fuel cell	(iii)	Rechargeable
(D)	Mercury cell	(iv)	Reaction at anode, $Zn \longrightarrow Zn^{2+} + 2e^-$

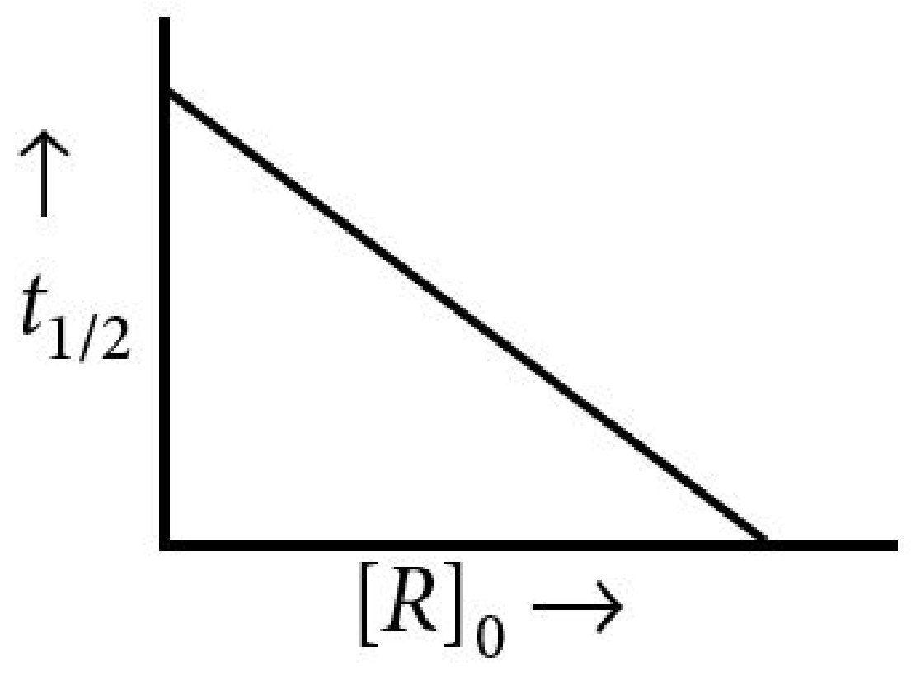
(a) (A) → (i), (B) → (ii), (C) → (iii), (D) → (iv)
(b) (A) → (iv), (B) → (iii), (C) → (i), (D) → (ii)
(c) (A) → (ii), (B) → (i), (C) → (iv), (D) → (iii)
(d) (A) → (iii), (B) → (i), (C) → (ii), (D) → (iv)

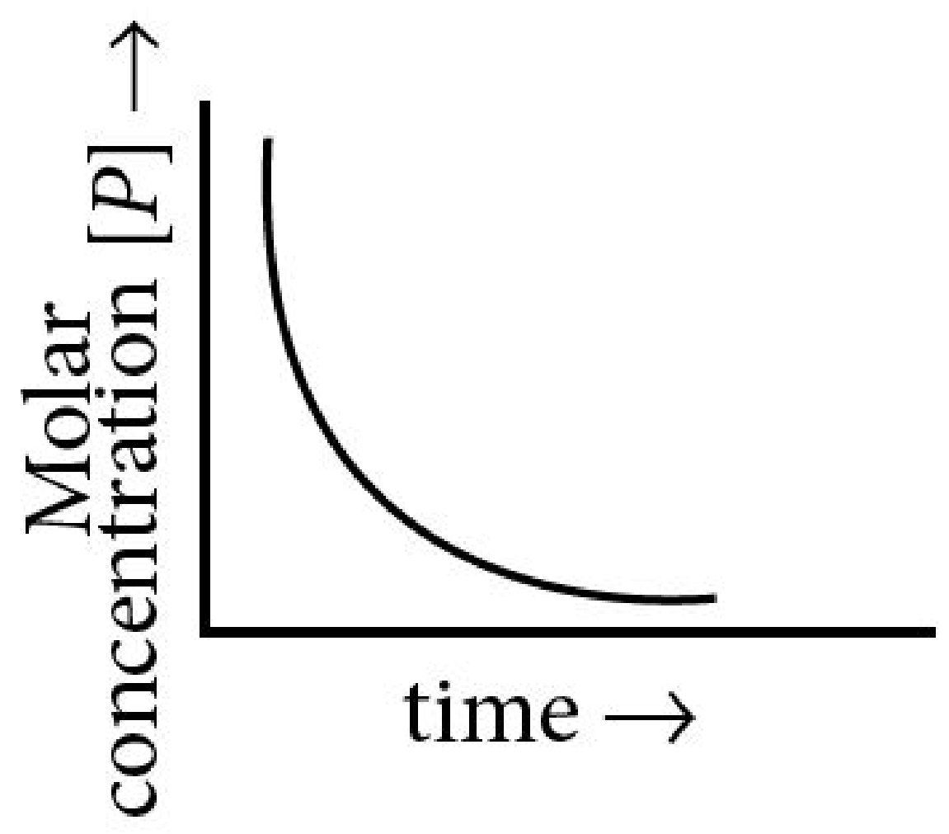
16. Arrange the following $CH_3CH_2CH_2Cl$ (I), $CH_3CH_2CHClCH_3$ (II), $(CH_3)_2CHCH_2Cl$ (III) and $(CH_3)_3CCl$ (IV) in order of decreasing tendency towards S_N2 reaction

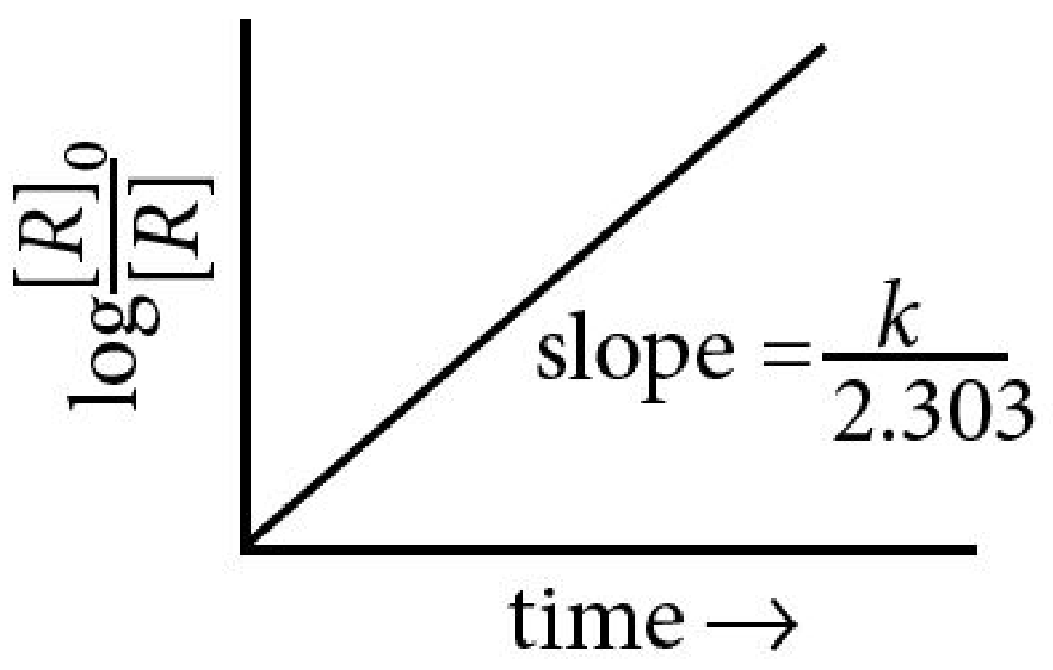
(a) I > III > II > IV (b) III > IV > II > I
(c) II > I > III > IV (d) IV > III > II > I

17. Which of the following graphs is/are correct for a first order reaction?

(I)


(II)


(III)


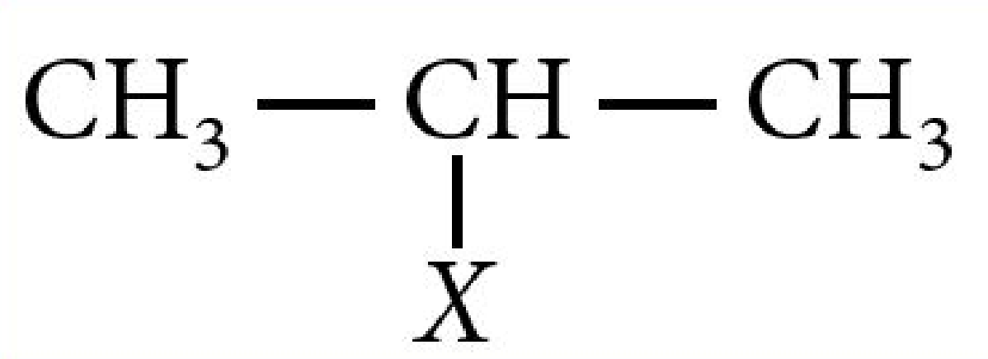
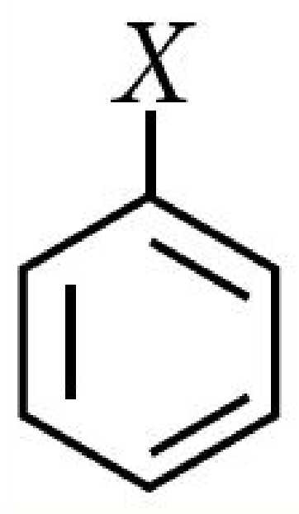
(IV)


(a) I and IV only (b) II and III only
(c) IV only (d) I and III only

18. The IUPAC name of tertiary butyl chloride is

(a) 2-chloro-2-methylpropane
(b) 3-chlorobutane
(c) 4-chlorobutane
(d) 1-chloro-3-methylpropane.

19. Match the structures of compounds given in Column I with the classes of compounds given in column II and select the correct option.

Column I		Column II	
(A)	 $CH_3-\underset{X}{\underset{\mid}{C}H}-CH_3$	(i)	Aryl halide
(B)	$CH_2=CH-CH_2-X$	(ii)	Alkyl halide
(C)		(iii)	Vinyl halide
(D)	$CH_2=CH-X$	(iv)	Allyl halide

(a) (A) – (ii); (B) – (iv); (C) – (i); (D) – (iii)
(b) (A) – (iii); (B) – (i); (C) – (ii); (D) – (iv)
(c) (A) – (iv); (B) – (ii); (C) – (i); (D) – (iii)
(d) (A) – (i); (B) – (iii); (C) – (iv); (D) – (ii)

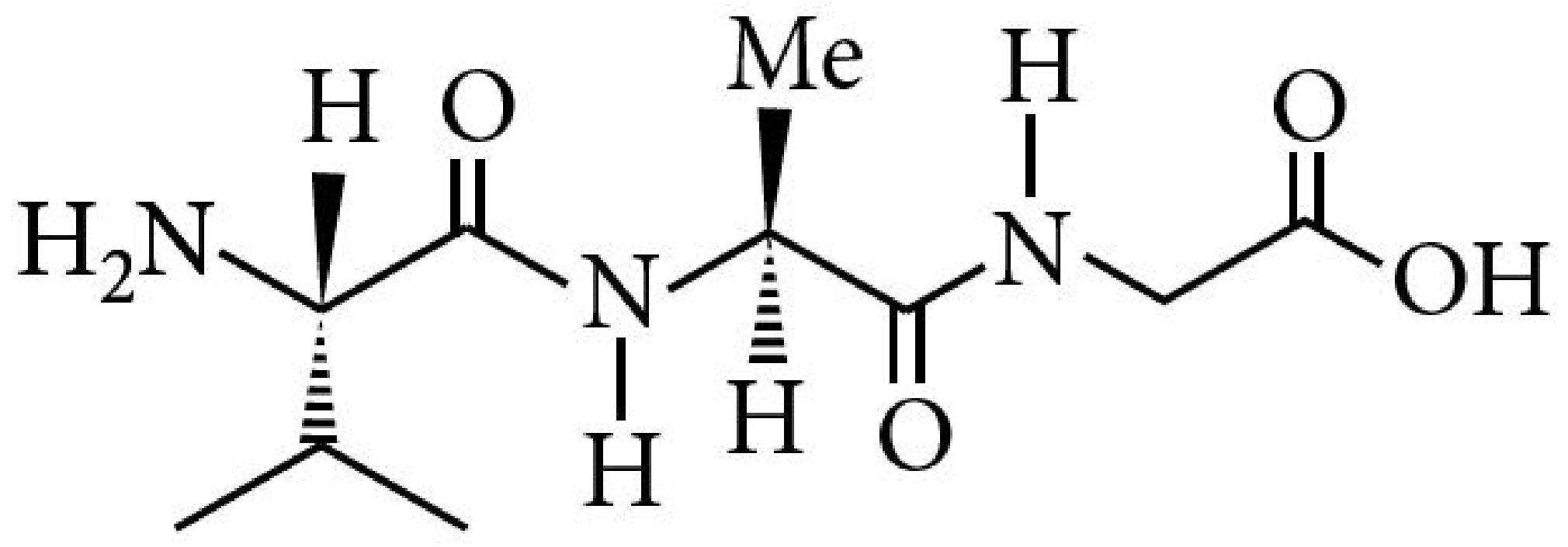
20. The colour of the coordination compounds depends on the crystal field splitting. What will be the correct order of absorption of wavelength of light in the visible region, for the complexes, $[Co(NH_3)_6]^{3+}$, $[Co(CN)_6]^{3-}$, $[Co(H_2O)_6]^{3+}$?

(a) $[Co(CN)_6]^{3-} > [Co(NH_3)_6]^{3+} > [Co(H_2O)_6]^{3+}$
(b) $[Co(NH_3)_6]^{3+} > [Co(H_2O)_6]^{3+} > [Co(CN)_6]^{3-}$
(c) $[Co(H_2O)_6]^{3+} > [Co(NH_3)_6]^{3+} > [Co(CN)_6]^{3-}$
(d) $[Co(NH_3)_6]^{3+} > [Co(CN)_6]^{3-} > [Co(H_2O)_6]^{3+}$

21. Which of the following amines will give carbylamine reaction?

(a) $(C_2H_5)_3N$
(b) $(C_2H_5)_2NH$
(c) $C_2H_5NH_2$
(d) $C_3H_7NHC_2H_5$

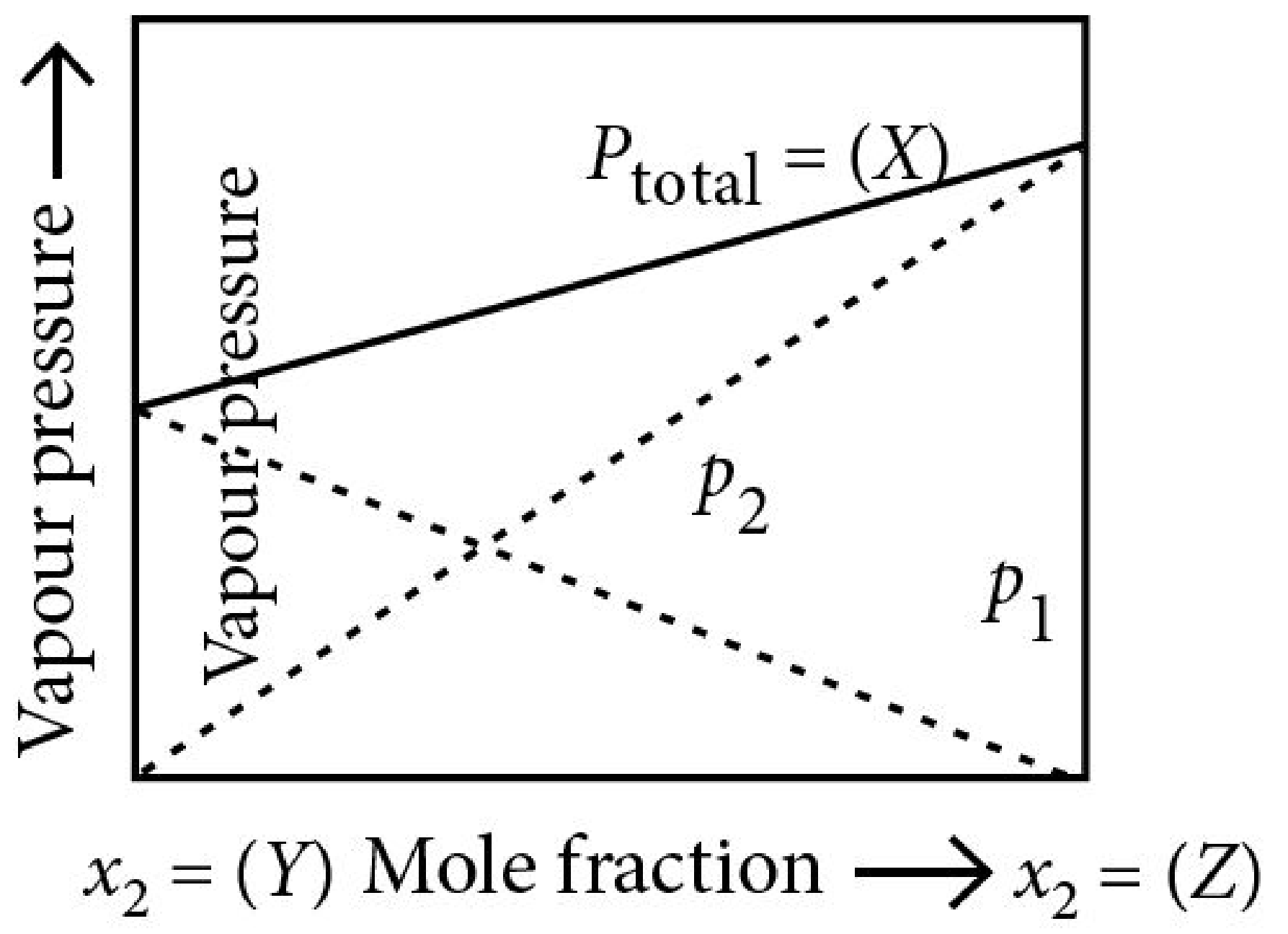
22. The given tripeptide can be synthesized from which of the following amino acids?



(a) Glycine, Leucine and Alanine
(b) Alanine, Isoleucine and Glycine
(c) Valine, Alanine and Glycine
(d) Alanine, Serine and Glycine

23. The correct order of magnetic moments (spin only values in B.M.) for the given compounds is (Atomic nos.: Mn = 25, Fe = 26, Co = 27)

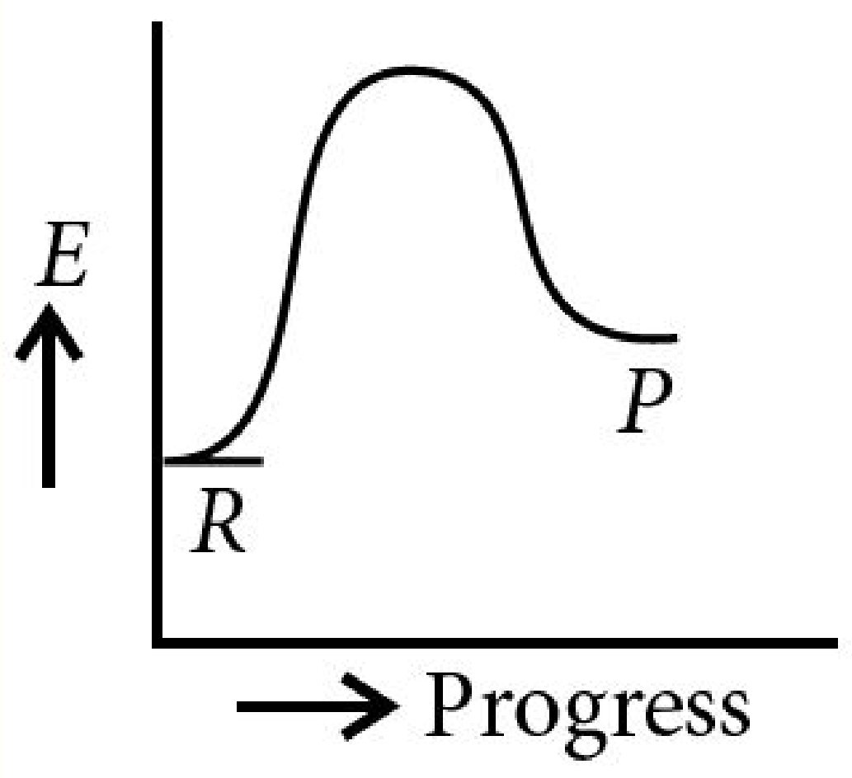
(a) $[MnCl_4]^{2-} > [CoCl_4]^{2-} > [Fe(CN)_6]^{4-}$
(b) $[MnCl_4]^{2-} > [Fe(CN)_6]^{4-} > [CoCl_4]^{2-}$
(c) $[Fe(CN)_6]^{4-} > [MnCl_4]^{2-} > [CoCl_4]^{2-}$
(d) $[Fe(CN)_6]^{4-} > [CoCl_4]^{2-} > [MnCl_4]^{2-}$.

24. 

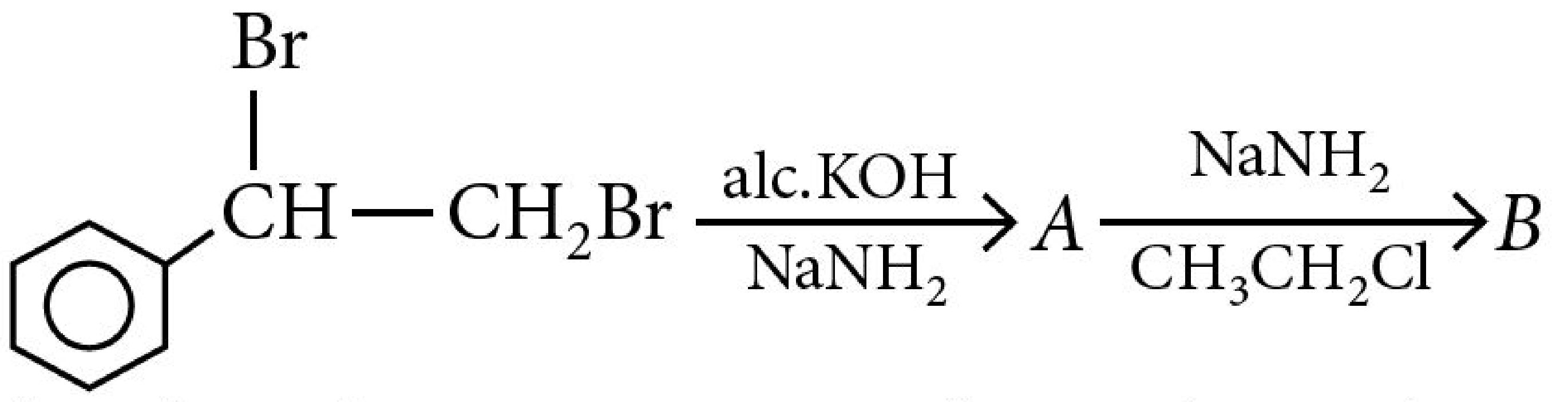
X, Y and Z in the above graph are

(a) $X = p_1 + p_2, Y = 1, Z = 1$
(b) $X = p_1 + p_2, Y = 0, Z = 1$
(c) $X = p_1 \times p_2, Y = 0, Z = 1$
(d) $Z = p_1 - p_2, Y = 1, Z = 0$

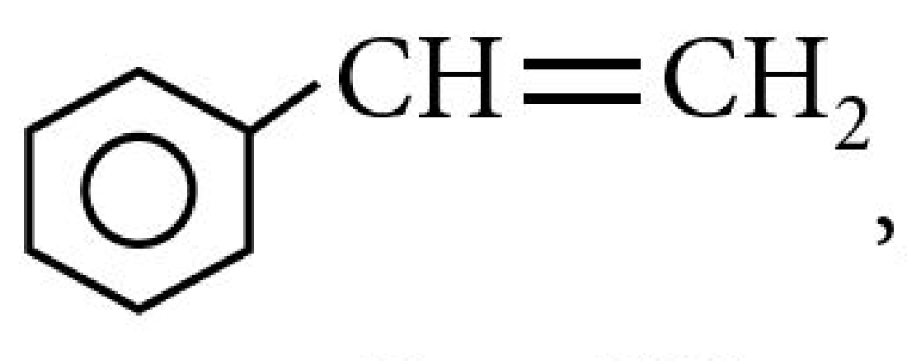
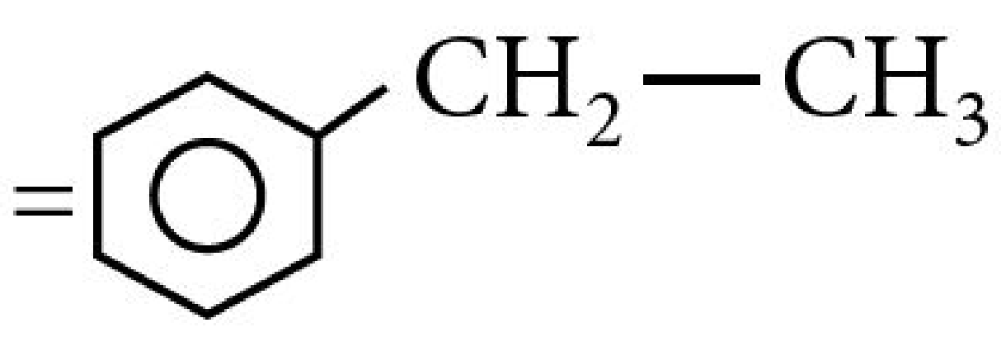
25. Match the column I with column II and mark the appropriate choice.

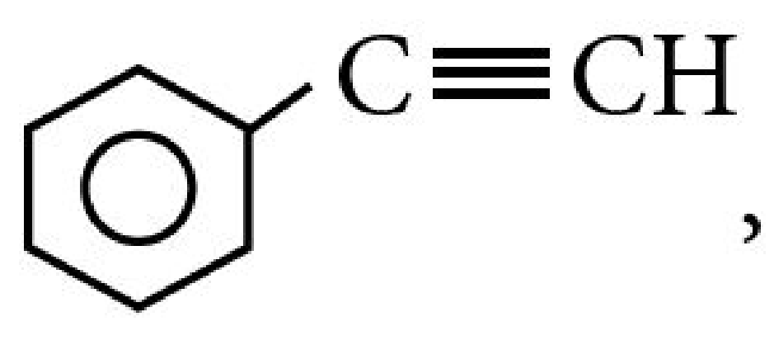
Column I		Column II	
(A)	Zero order	(i)	$\log\frac{k_2}{k_1} = \frac{E_a}{2.303R}\left[\frac{T_2 - T_1}{T_1T_2}\right]$
(B)	First order	(ii)	
(C)	Endothermic reaction	(iii)	$k = \frac{2.303}{t}\log\frac{[A]_0}{[A]}$
(D)	Activation energy	(iv)	$k = \frac{1}{t}([A]_0 - [A])$

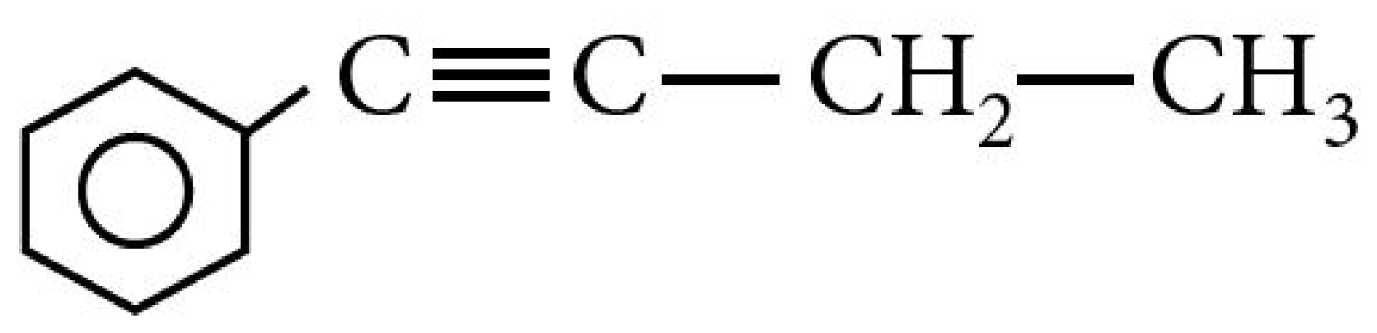
(a) (A) – (iv), (B) – (iii), (C) – (ii), (D) – (i)
(b) (A) – (i), (B) – (ii), (C) – (iii), (D) – (iv)
(c) (A) – (ii), (B) – (iii), (C) – (iv), (D) – (i)
(d) (A) – (iii), (B) – (iv), (C) – (i), (D) – (ii)

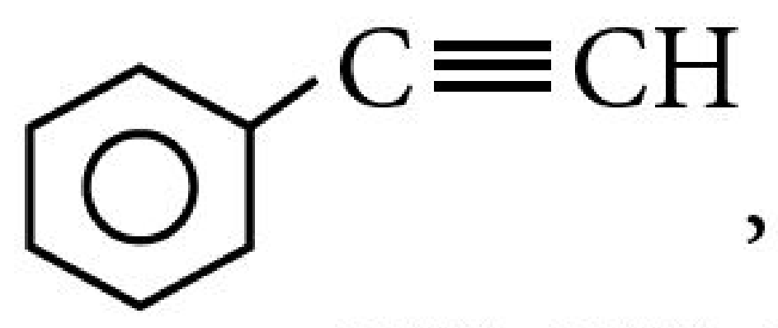
26. 
$C_6H_5-\underset{}{\overset{Br}{\overset{\mid}{C}}H}-CH_2Br \xrightarrow[NaNH_2]{alc.KOH} A \xrightarrow[CH_3CH_2Cl]{NaNH_2} B$

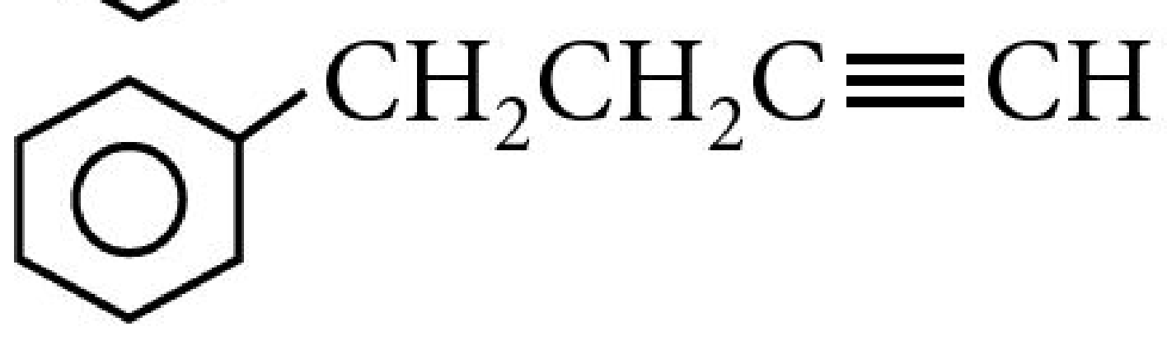
In the given sequence of reactions A and B respectively are

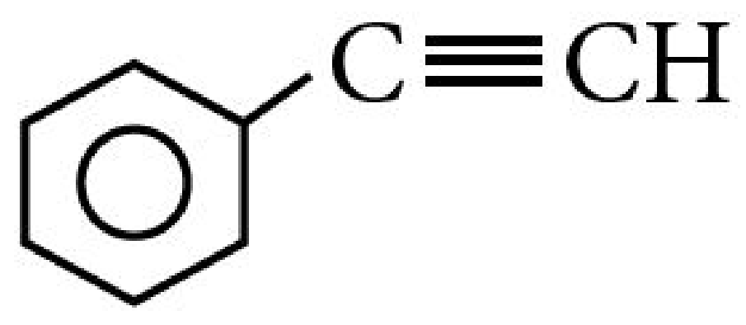
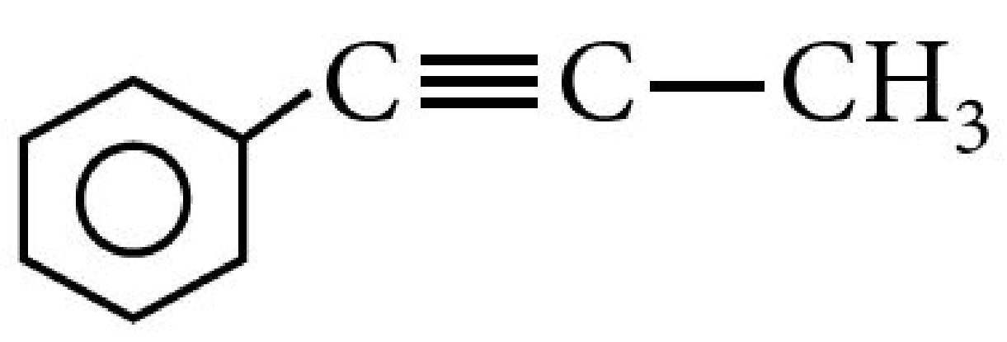
(a) A = , B = 

(b) A = ,

B = 

(c) $A =$ 

$B =$ 

(d) $A =$  , $B =$ 

27. The tendencies of the electrodes made up of Cu, Zn and Ag to release electrons when dipped in their respective salt solutions decrease in the order

(a) Zn > Ag > Cu
(b) Cu > Zn > Ag
(c) Zn > Cu > Ag
(d) Ag > Cu > Zn

28. Consider the following reaction sequence,

$$CH_3CH(OH)CH_3 \xrightarrow[\text{Heat}]{\text{Conc. } H_2SO_4} X \xrightarrow{H_2O,\text{ dil. } H_2SO_4} Y$$

X and Y in the reaction respectively are

(a) $CH_3CH{=}CH_2$, $CH_3CH(OH)CH_3$
(b) $CH_3CH{=}CHCH_3$, $CH_3CH_2CH_2OH$
(c) $CH_3CH_2CH{=}CH_2$, $CH_3CH_2CH_2OH$
(d) $CH_3CH_2CH_2CH_3$, $CH_3CH(OH)CH_2CH_3$

29. Aniline can be converted into benzylamine by which of the following processes in sequence?

(a) $NaNO_2$ + HCl, CuCN, H_2/Ni
(b) Br_2/CCl_4, KCN, $LiAlH_4$
(c) HNO_2, $K_2Cr_2O_7/H^+$, Sn + HCl
(d) CH_3OH, $KMnO_4$, OH^-, H_3O^+

30. Match the complex ions given in column I with the hybridisation and number of unpaired electrons given in column II and select the correct option.

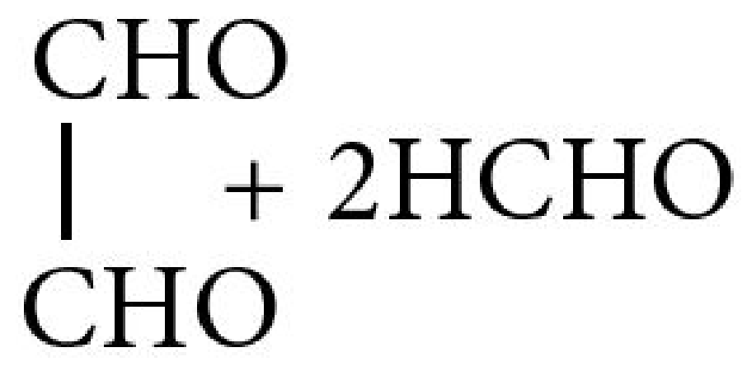
Column I (Complex ion)		**Column II (Hybridisation, number of unpaired electrons)**	
(A)	$[Cr(NH_3)_6]^{3+}$	1.	dsp^2, 0
(B)	$[Ni(CN)_4]^{2-}$	2.	sp^3d^2, 5
(C)	$[Ni(NH_3)_6]^{2+}$	3.	d^2sp^3, 3
(D)	$[MnF_6]^4$	4.	sp^3, 4
		5.	sp^3d^2, 2

(a) (A)-(3); (B)-(1); (C)-(5); (D)-(2)
(b) (A)-(4); (B)-(3); (C)-(2); (D)-(1)
(c) (A)-(3); (B)-(2); (C)-(4); (D)-(1)
(d) (A)-(4); (B)-(1); (C)-(2); (D)-(3)

31. Benzaldehyde can be prepared from benzene by passing vapours of _____ and _____ in its solution in presence of catalyst mixture of aluminium chloride and cuprous chloride. The reaction is known as _____ .

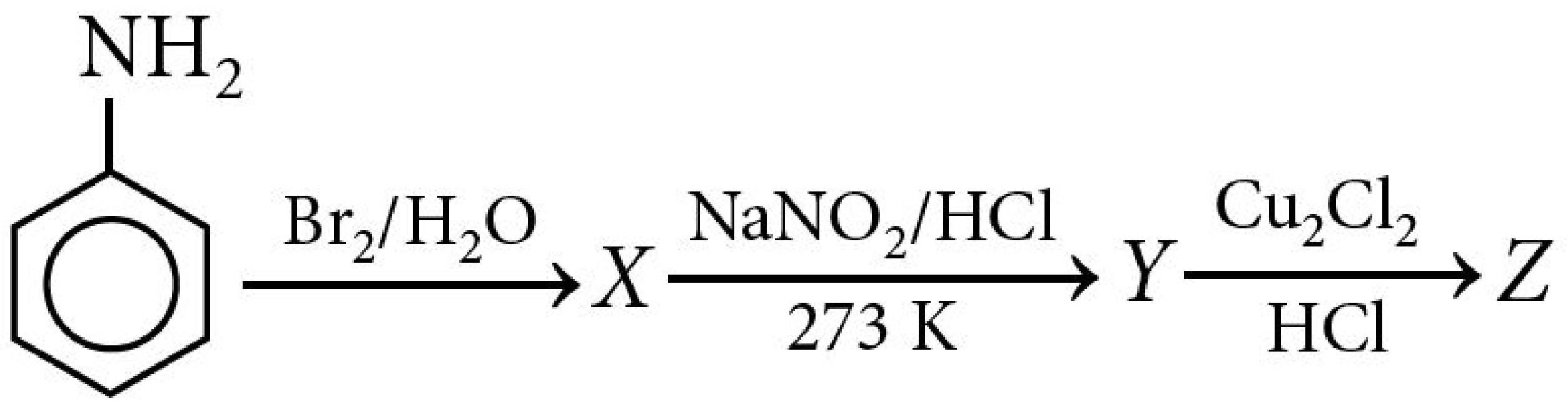
(a) HCl, $SnCl_4$, Rosenmund reduction
(b) CO, HCl, Gattermann–Koch reaction
(c) CO_2, H_2SO_4, Clemmensen reduction
(d) O_3, alcohol, Wolff–Kishner reduction

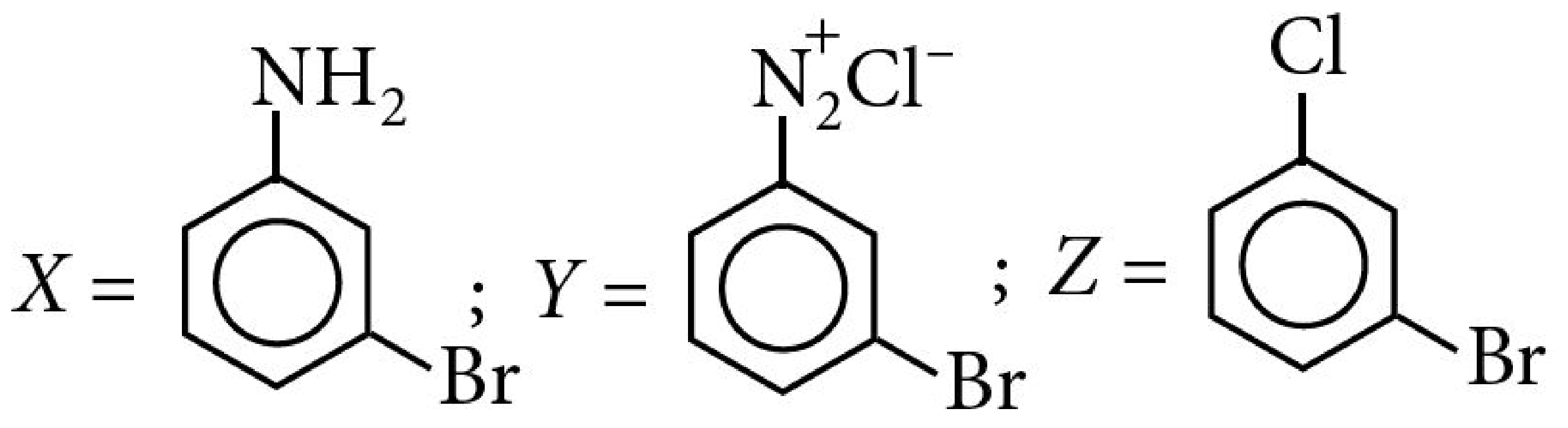
32. Buta-1, 3-diene was subjected to ozonolysis to prepare aldehydes. Which of the following aldehydes will be obtained during the reaction?

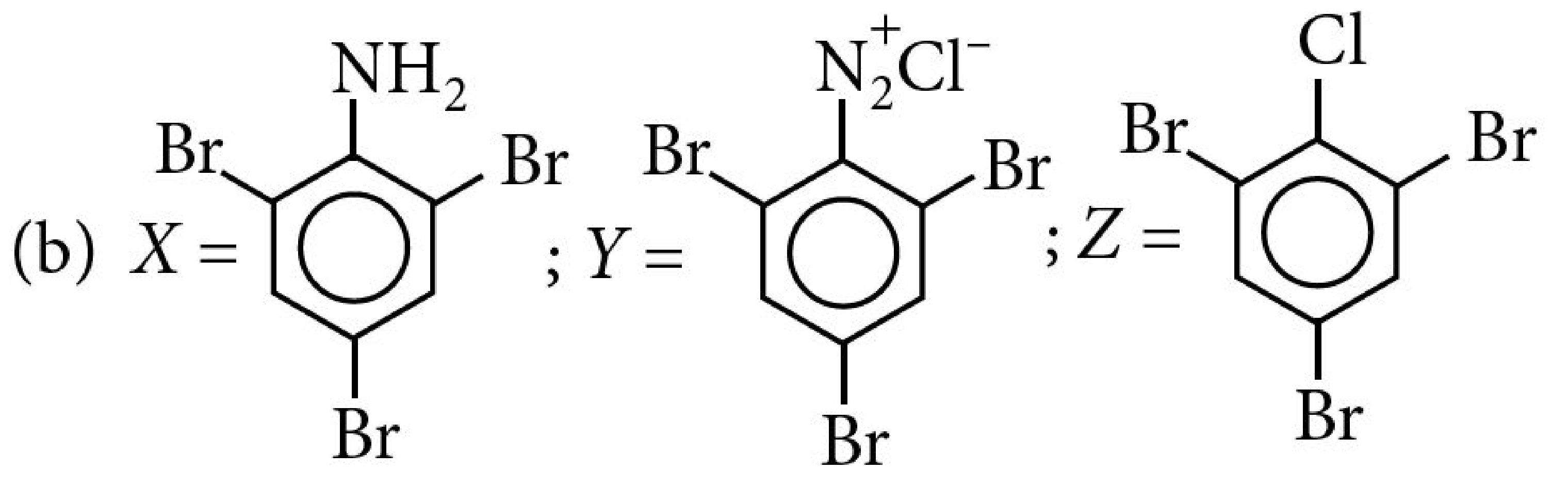
(a) 
$\begin{array}{c}CHO\\|\\CHO\end{array} + 2HCHO$

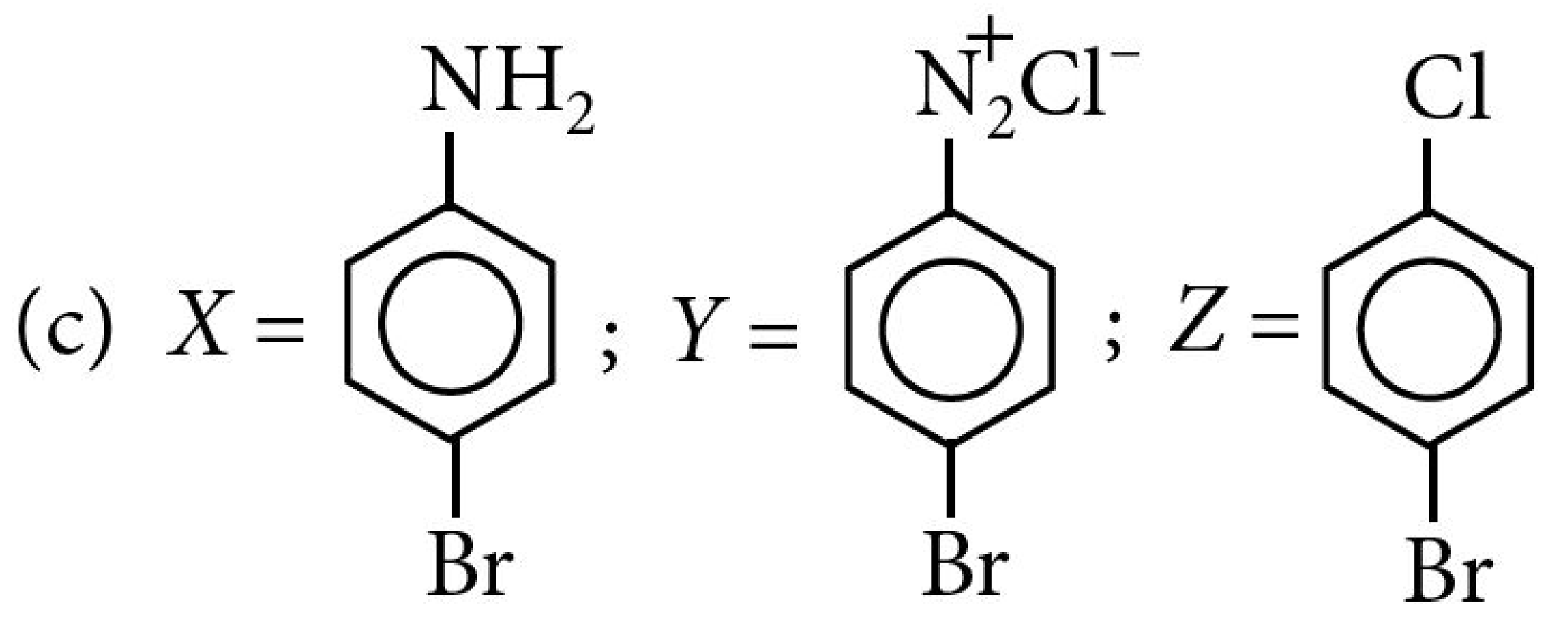
(b) $CH_3CHO + 2HCHO$
(c) $CH_3CH_2CHO + CH_3CHO$
(d) $2CH_3CH_2CHO$

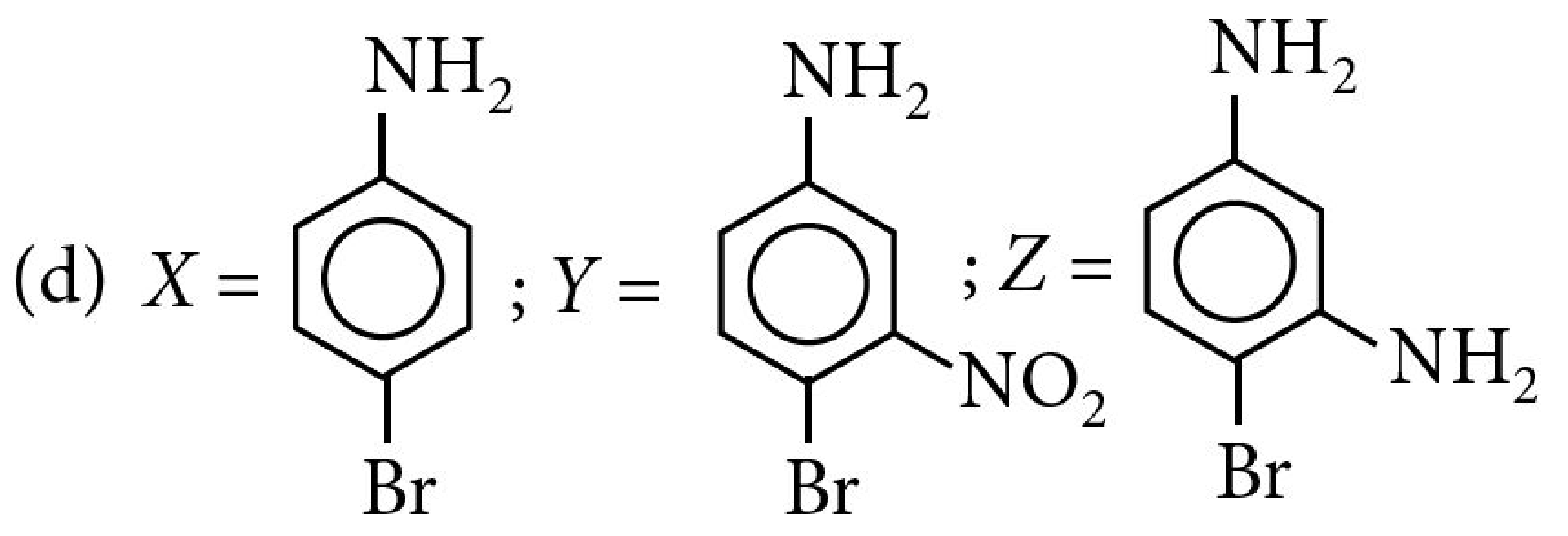
33. In the given sequence of reactions, identify X, Y and Z.



(a) 

(b) 

(c) 

(d) 

Read the following passage and answer the next five questions based on it.

Valence bond theory considers the bonding between the metal ion and the ligands as purely covalent. On the other hand, crystal field theory considers the metal-ligand bond to be ionic arising from electrostatic interaction between the metal ion and the ligands. In

coordination compounds, the interaction between the ligand and the metal ion causes the five d-orbitals to split-up. This is called crystal field splitting and the energy difference between the two sets of energy level is called crystal field splitting energy. The crystal field splitting energy (Δ_o) depends upon the nature of the ligand. The actual configuration of complexes is divided by the relative values of Δ_o and P (pairing energy).
If $\Delta_o < P$, then complex will be high spin.
If $\Delta_o > P$, then complex will be low spin.

34. Which of the following ligand has lowest Δ_o value?
(a) CN^- (b) CO (c) F^- (d) NH_3

35. The crystal field splitting energy for octahedral (Δ_o) and tetrahedral (Δ_t) complex is related as
(a) $\Delta_t = \frac{1}{2}\Delta_o$ (b) $\Delta_t = \frac{4}{9}\Delta_o$
(c) $\Delta_t = \frac{3}{5}\Delta_o$ (d) $\Delta_t = \frac{2}{5}\Delta_o$

36. On the basis of crystal field theory, the electronic configuration of d^4 in two conditions : (i) $\Delta_o > P$ and (ii) $\Delta_o < P$ are

	(i)	**(ii)**
(a)	$t_{2g}^4 e_g^0$	$t_{2g}^3 e_g^1$
(b)	$t_{2g}^3 e_g^1$	$t_{2g}^4 e_g^0$
(c)	$t_{2g}^3 e_g^1$	$t_{2g}^3 e_g^1$
(d)	$t_{2g}^4 e_g^0$	$t_{2g}^4 e_g^0$

37. Electronic configuration of d-orbitals in $[Ti(H_2O)_6]^{3+}$ ion in an octahedral crystal field is
(a) $t_{2g}^1 e_g^0$ (b) $t_{2g}^2 e_g^0$ (c) $t_{2g}^0 e_g^1$ (d) $t_{2g}^1 e_g^1$

38. Using crystal field theory, what is the magnetic moment of central metal ion of $[FeF_6]^{4-}$?
(a) 1.79 B.M. (b) 2.83 B.M.
(c) 3.85 B.M. (d) 4.9 B.M.

Read the following passage and answer the next five questions based on it.

Aldehydes and ketones are reduced to primary and secondary alcohols respectively by $NaBH_4$ or $LiAlH_4$ as well as catalytic hydrogenation. The carbonyl group of aldehydes and ketones is reduced to $\rangle CH_2$ group on treatment with Zn-Hg and conc. HCl (Clemmensen reduction) or with hydrazine followed by NaOH or KOH in highly boiling solvent such as ethylene glycol (Wolff-Kishner reduction).

Aldehydes differ from ketones in their oxidation reactions. Aldehydes are easily oxidised to carboxylic acids on treatment with HNO_3, $KMnO_4$, $K_2Cr_2O_7$ etc. Even mild oxidising agents mainly Tollens' reagent and Fehling's solution also oxidise aldehydes. Ketones are generally oxidised under vigorous conditions *i.e.*, strong oxidising agents and at elevated temperatures, to give mixture of carboxylic acids having lesser number of C-atoms than the parent ketone.

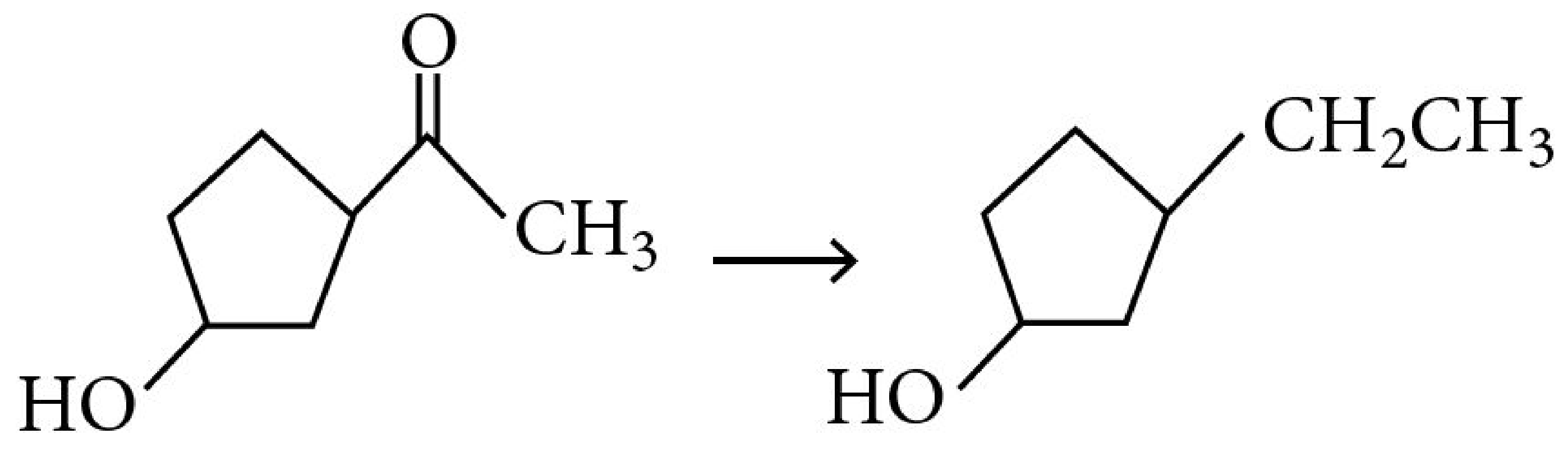
39. Which of the following cannot be made by reduction of ketone or aldehyde with $NaBH_4$ in methanol?
(a) 1-Butanol (b) 2-Butanol
(c) 2-Methyl-1-propanol
(d) 2-Methyl-2-propanol

40. The carbonyl compound producing an optically active product by reaction with $LiAlH_4$ is
(a) propanone (b) butanone
(c) 3-pentanone (d) benzophenone.

41. A substance $C_4H_{10}O(X)$ yields on oxidation a compound C_4H_8O which gives an oxime and a positive iodoform test. The substance X on treatment with conc. H_2SO_4 gives C_4H_8. The structure of the compound (X) is
(a) $CH_3CH_2CH_2CH_2OH$
(b) $CH_3CH(OH)CH_2CH_3$
(c) $(CH_3)_3COH$
(d) $CH_3CH_2{-}O{-}CH_2CH_3$

42. A carbonyl compound with molecular weight 86, does not reduce Fehling's solution but forms crystalline bisulphite derivatives and gives iodoform test. The possible compounds can be
(a) 2-pentanone and 3-pentanone
(b) 2-pentanone and 3-methyl-2-butanone
(c) 2-pentanone and pentanal
(d) 3-pentanone and 3-methyl-2-butanone.

43. The appropriate reagent for the following transformation is



(a) NH_2NH_2, ^-OH (b) $NaBH_4$
(c) H_2/Ni (d) $AlCl_3$

44. In both DNA and RNA, heterocyclic base and phosphate ester linkages are at

(a) C-5′ and C-2′ respectively of the sugar molecule
(b) C-2′ and C-5′ respectively of the sugar molecule
(c) C-1′ and C-5′ respectively of the sugar molecule
(d) C-5′ and C-1′ respectively of the sugar molecule.

45. The correct Nernst equation for the given cell $Pt_{(s)} | Br_{2(l)} | Br^- (M) || H^+ (M) | H_{2(g)}$ (1 bar) $| Pt_{(s)}$ is

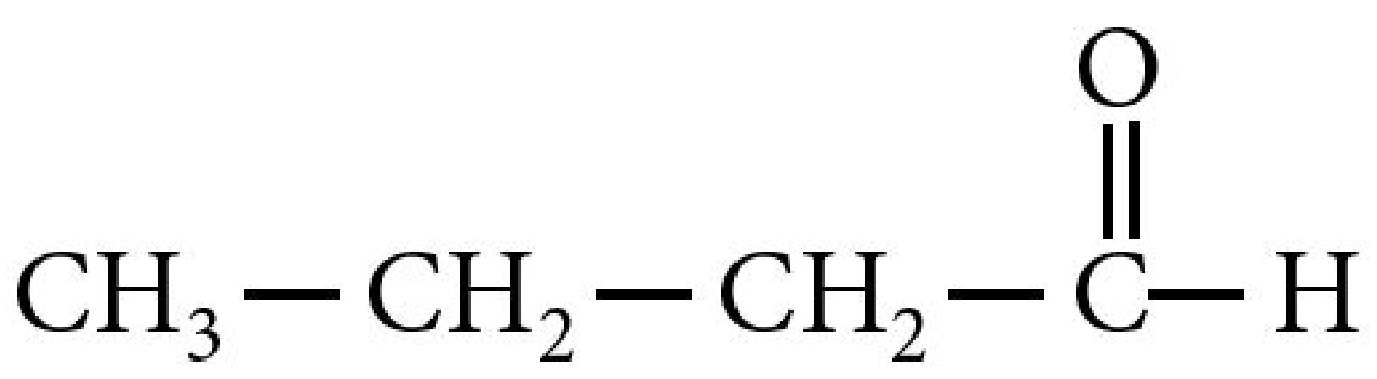
(a) $E_{cell} = E^{\circ}_{cell} - \frac{0.0591}{2}\log\frac{[Br_{2(l)}][H_2]}{[H^+]^2[Br^-]^2}$

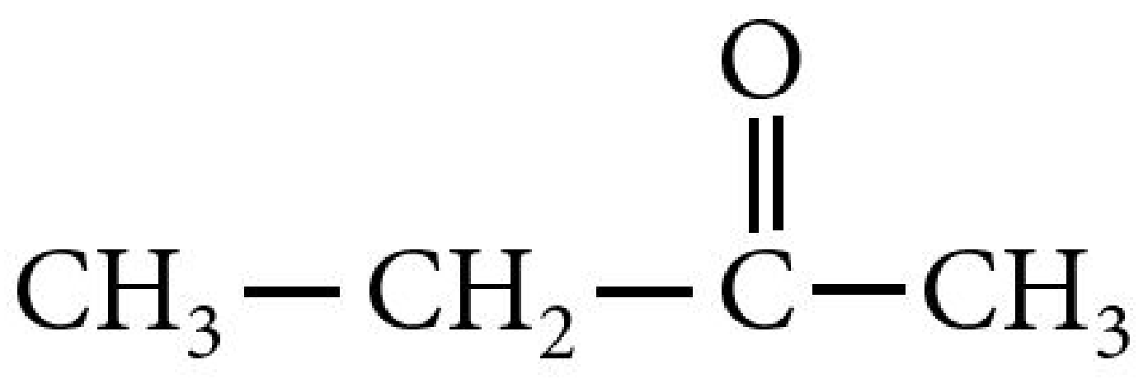
(b) $E_{cell} = E^{\circ}_{cell} - \frac{0.0591}{2}\log\frac{[H^+]^2[Br^-]^2}{[Br_{2(l)}][H_2]}$

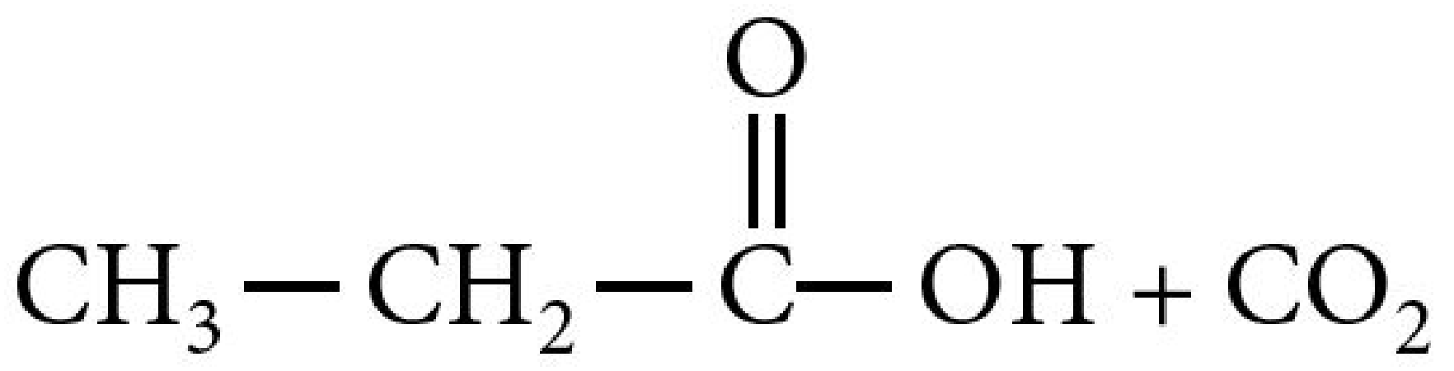
(c) $E_{cell} = E^{\circ}_{cell} - \frac{0.0591}{2}\log\frac{[H^+]^2[H_2]}{[Br_{2(l)}][Br^-]^2}$

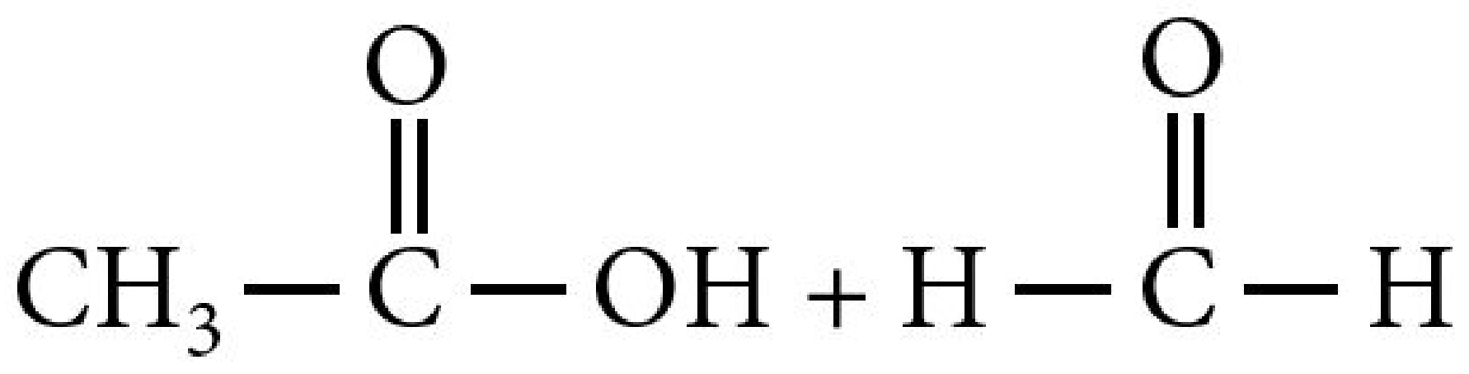
(d) $E_{cell} = E^{\circ}_{cell} - \frac{0.0591}{2}\log\frac{[Br_{2(l)}][Br^-]^2}{[H^+]^2[H_2]}$

46. Addition of water to alkynes occurs in acidic medium and in the presence of Hg^{2+} ions as a catalyst. Which of the following products will be formed on addition of water to but-1-yne under these conditions?

(a) 
$CH_3-CH_2-CH_2-\overset{O}{\overset{\|}{C}}-H$

(b) 
$CH_3-CH_2-\overset{O}{\overset{\|}{C}}-CH_3$

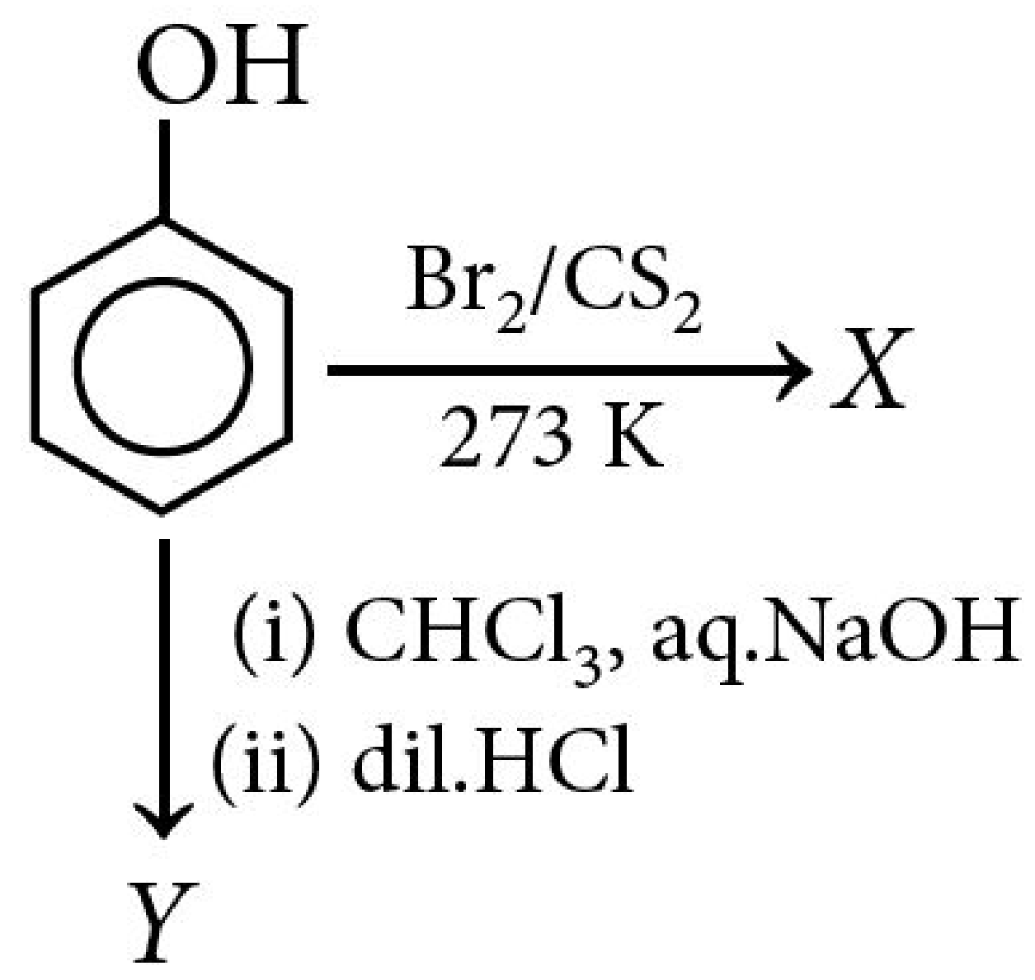
(c) 
$CH_3-CH_2-\overset{O}{\overset{\|}{C}}-OH + CO_2$

(d) 
$CH_3-\overset{O}{\overset{\|}{C}}-OH + H-\overset{O}{\overset{\|}{C}}-H$

47. Among the following ion which one has the highest paramagnetism?

(a) $[Cr(H_2O)_6]^{3+}$
(b) $[Fe(H_2O)_6]^{2+}$
(c) $[Cu(H_2O)_6]^{2+}$
(d) $[Zn(H_2O)_6]^{2+}$

48. In the given reactions,



X and *Y* are

(a) *X* = Bromobenzene, *Y* = Acetophenone
(b) *X* = *o*- and *p*-Bromophenol, *Y* = Salicylaldehdye
(c) *X* = *p*-Bromophenol, *Y* = Salicylic acid
(d) *X* = *o*-Bromophenol, *Y* = Benzoic acid

49. Benzenediazonium chloride reacts with phenol to give *p*-hydroxyazobenzene, an orange dye. This reaction is known as

(a) coupling reaction
(b) carbylamine reaction
(c) Gattermann reaction
(d) Hinsberg's reaction

50. Which of the following statements is correct about stability of the complexes of lanthanoids?

(a) Stability of complexes increases as the size of lanthanoid decreases.
(b) Stability of complexes decreases as the size of lanthanoid decreases.
(c) Lanthanoids do not form complexes.
(d) All the complexes of lanthanoids have same stability.

TRIO

Here are the nine shuffled words containing 3 sets of trio. The three letters of trio can be arranged in any sequence. Complete these words by finding 3 sets of trio.

OX — — —
— — — THYL
M — — — UM
— — — E
COU — — — B
NYH — — —
OX — — — TION
— — — MAGNETIC
— — — ABATIC

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month.
Winners' names will be published in next issue.

SOLUTIONS

1. (c) : Ideal solutions obey Raoult's law where the intermolecular interactions between the different components (*A* – *B* interactions) are of the same magnitude as the intermolecular interactions found in the pure components (*A* – *A* and *B* – *B* interactions).

2. (a) : Saytzeff rule applies here and hence, a mixture of 1-butene and 2-butene is obtained out of which 2-butene is the major product.

3. (c) : $NaCl \longrightarrow Na^+ + Cl^-, i = 2$

$Na_2SO_4 \longrightarrow 2Na^+ + SO_4^{2-}, i = 3 \Rightarrow \pi = iCRT$

For the same concentration, $\pi \propto i$

Thus, osmotic pressure is more for Na_2SO_4.

4. (d) : Electron donating groups ($-OC_2H_5$, $-CH_3$ etc.) tend to decrease and electron withdrawing groups ($-NO_2$, $—CN$ etc.) tend to increase the acidic character of phenols. Since $—OCH_3$ is a more powerful electron donating group than $-CH_3$ group, therefore, *p*-methylphenol is slightly more acidic than that *p*-methoxyphenol while *p*-nitrophenol is the strongest acid.

5. (d) : For the reaction, $2x + y_2 \longrightarrow 2xy$

Rate of reaction $= k[x]^a[y_2]^b$

where *a* and *b* are the order of reaction with respect to *x* and y_2 respectively. From the given data, we obtain the following expressions:

$1.6 \times 10^{-4} = k[0.50]^a[0.50]^b$ ...(i)

$3.2 \times 10^{-4} = k[0.50]^a[1.0]^b$ ...(ii)

$3.2 \times 10^{-4} = k[1.0]^a[1.0]^b$ ...(iii)

Dividing eq. (i) by eq. (ii), we get

$$\left(\frac{1.6\times10^{-4}}{3.2\times10^{-4}}\right)=\left(\frac{0.50}{1.0}\right)^a \text{ or } \left(\frac{1}{2}\right)=\left(\frac{1}{2}\right)^b \text{ or } b=1$$

Now dividing eq. (ii) by eq. (iii), we get

$$\frac{3.2\times10^{-4}}{3.2\times10^{-4}}=\left(\frac{0.50}{1.0}\right)^a \text{ or } 1=\left(\frac{1}{2}\right)^a \text{ or } a=0$$

$\therefore$ Rate of reaction $= k[y_2]$

6. (a) : Acetaldehyde does not undergo Cannizzaro reaction since it contains α-H atoms while formaldehyde, trimethylacetaldehyde and benzaldehyde undergo Cannizzaro reaction since they do not contain α-H atoms.

7. (c)

8. (a) : According to Henry's law,

$x_{N_2} \times K_H = p_{N_2}$ (p_{N_2} = Partial pressure of N_2)

Given, total pressure = 5 atm, mole fraction of $N_2 = 0.8$

$\therefore$ Partial pressure of $N_2 = 0.8 \times 5 = 4$

$\Rightarrow x_{N_2} \times 1 \times 10^5 = 4 \Rightarrow x_{N_2} = 4 \times 10^{-5}$

No. of moles of H_2O, $n_{H_2O} = 10$

No. of moles of N_2, $n_{N_2} = ?$

$$\frac{n_{N_2}}{n_{N_2}+n_{H_2O}}=x_{N_2}=4\times10^{-5}$$

$$\Rightarrow \frac{n_{N_2}}{10+n_{N_2}}=4\times10^{-5} \qquad [\because n_{N_2} <<< 10]$$

$\Rightarrow n_{N_2} = 4 \times 10^{-4}$

9. (b) : $\underset{\text{(Amino acid)}}{H_2NCH_2COOH} \longrightarrow \underset{\text{(Zwitter ion)}}{H_3\overset{+}{N}CH_2COO^-}$

10. (b)

11. (c) : In each vertical column of transition elements, the elements of second and third transition series resemble each other more closely than the elements of first and second transition series on account of lanthanide contraction. The pairs of elements such as Zr-Hf, Mo-W, Nb-Ta, etc; possess almost the same properties.

12. (b) : For first order reaction,

$$k=\frac{0.693}{t_{1/2}}=\frac{2.303}{t}\log\frac{a}{(a-x)}$$

$$\frac{0.693}{15}=\frac{2.303}{t}\log\frac{0.12}{0.08}=\frac{2.303}{t}(0.1760)$$

$$\frac{0.693}{15}=\frac{0.405}{t} \Rightarrow t=\frac{15\times0.405}{0.693}=8.77 \text{ min}$$

13. (b) : It is known as Swarts reaction.

14. (c) : Mass of the solute, $C_2H_4(OH)_2$ = 222.6 g

Molar mass of solute, $C_2H_4(OH)_2$ = 62 g mol^{-1}

$$\therefore \text{ Moles of the solute} = \frac{222.6 \text{ g}}{62 \text{ g mol}^{-1}} = 3.59$$

$$\text{Volume of solution} = \frac{422.6}{1.072 \text{ g mL}^{-1}} = 394.2 \text{ mL}$$

$$\text{Molarity} = \frac{3.59 \text{ moles}}{0.3942 \text{ L}} = 9.11 \text{ mol L}^{-1}$$

15. (b)

16. (a) : In S_N2 reaction, the transition state, there will be five groups attached to the C-atom at which reaction occurs. Thus, there will be crowding in the transition state and the bulkier the groups, greater the steric effect and hence, reaction will be more hindered.

Hence, the correct order is I > III > II > IV.

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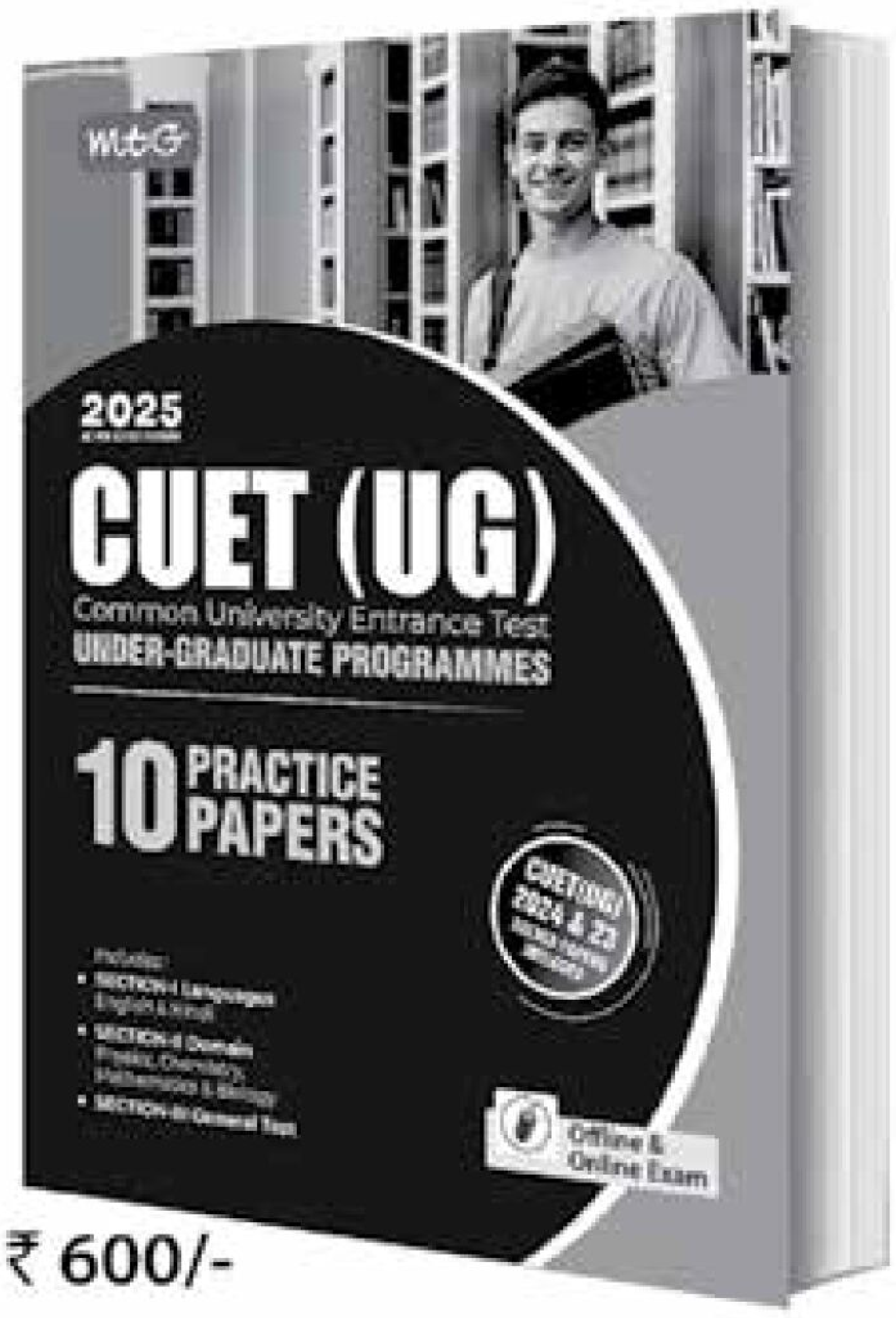

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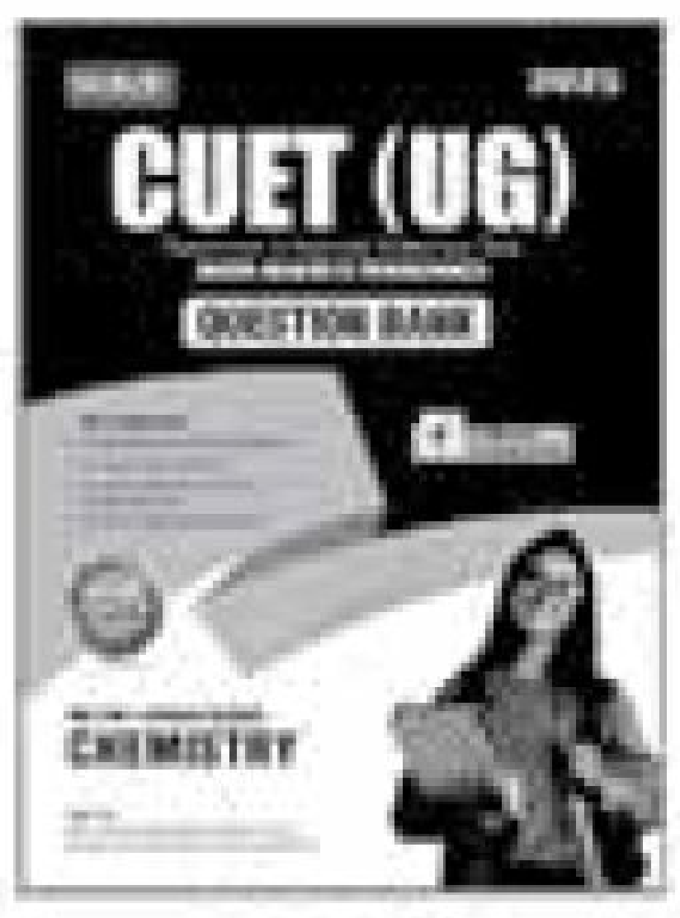
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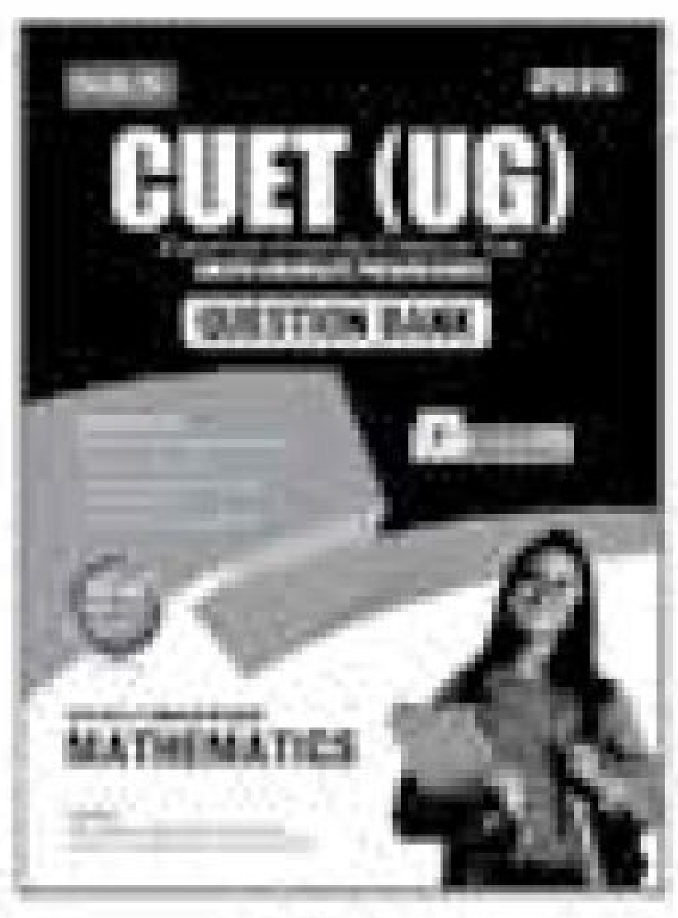
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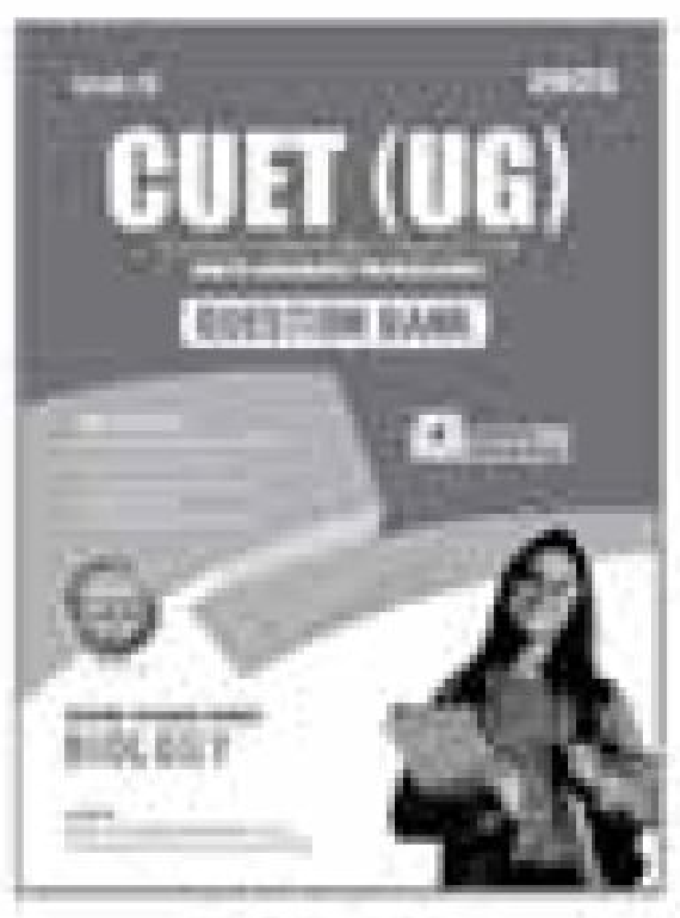
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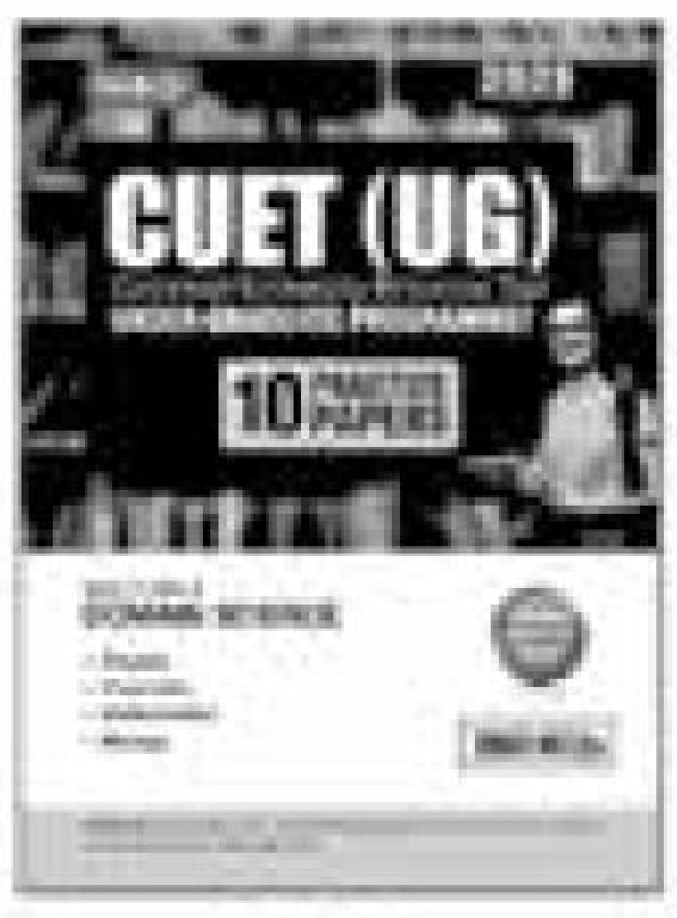
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17. (a) : For a first order reaction

$$t_{1/2}=\frac{0.693}{k}\text{ and rate}=-\frac{d[R]}{dt}=k[R]$$

18. (a) **19. (a)**

20. (c) : As strength of ligand increases, crystal field splitting energy increases.

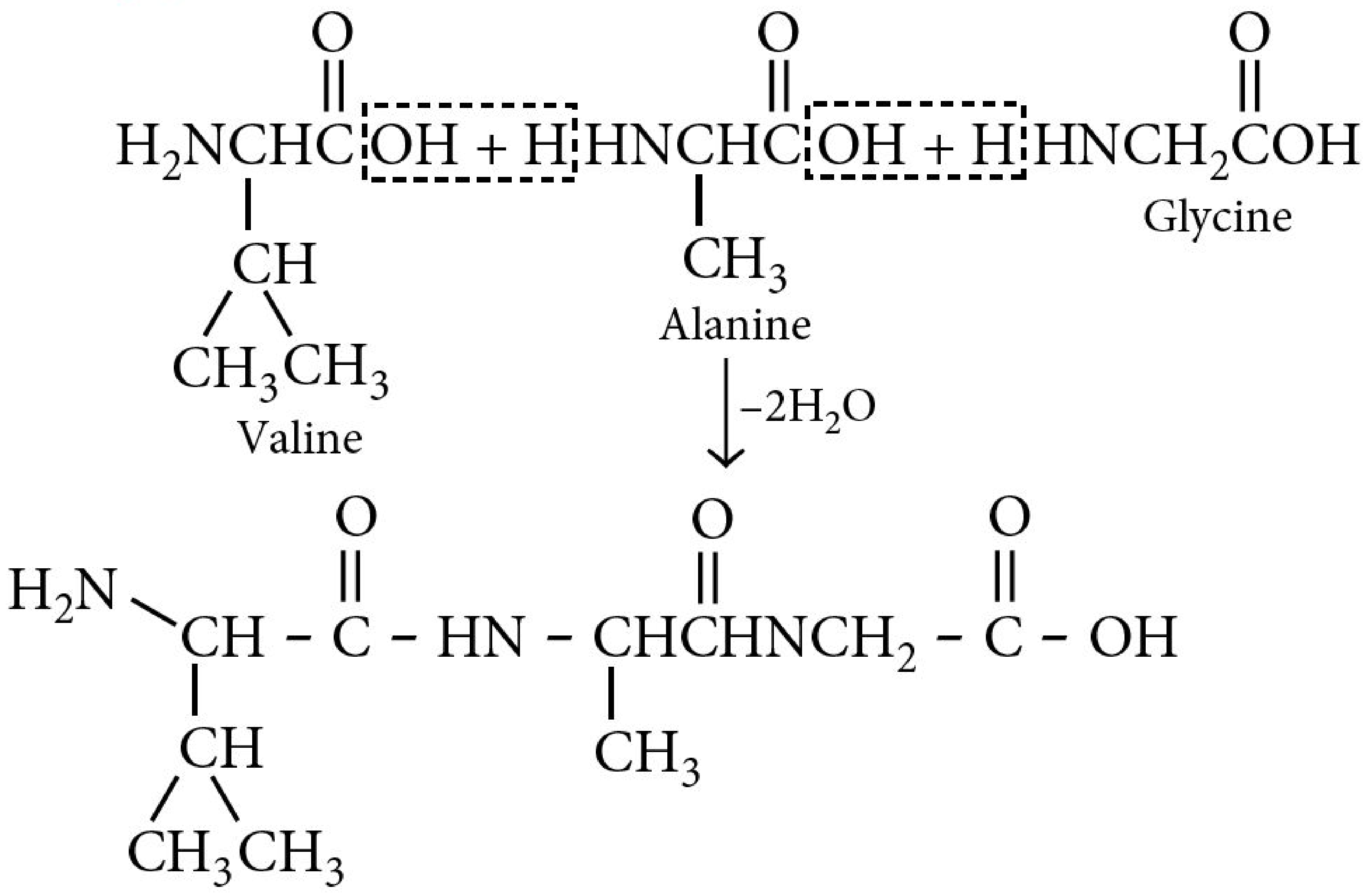
Now, $\Delta E=\frac{hc}{\lambda}$

So, as CFSE increases, ΔE increases and λ decreases. Hence, the correct order is

$[Co(H_2O)_6]^{3+} > [Co(NH_3)_6]^{3+} > [Co(CN)_6]^{3-}$

21. (c) : Only primary amines will give carbylamine reaction.

22. (c) :

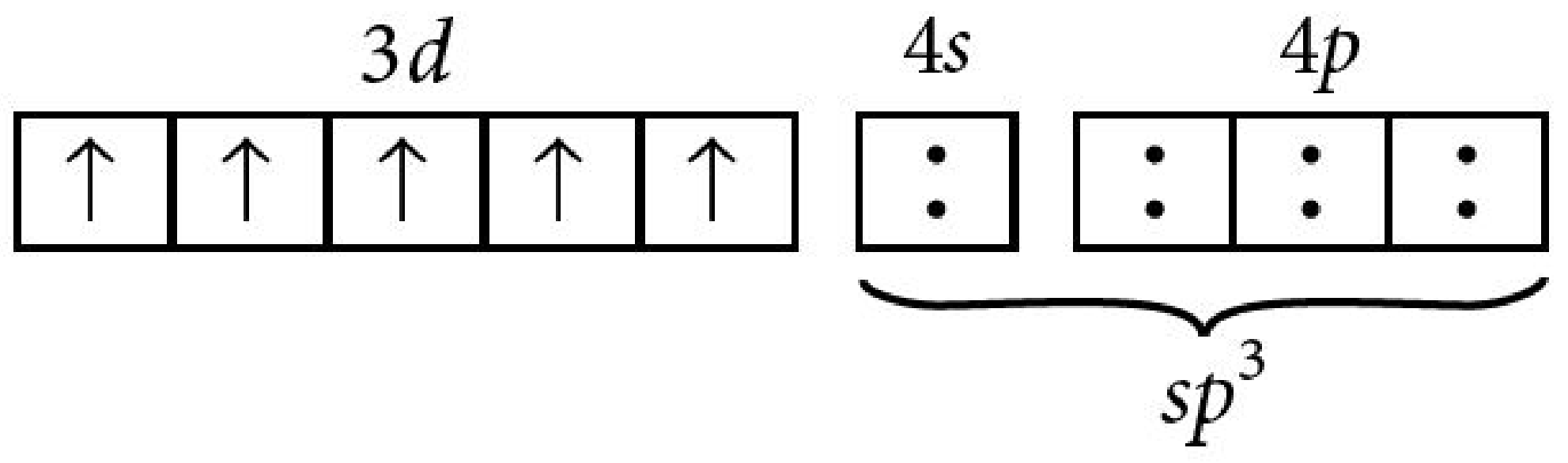

Valine
Alanine
Glycine
−2H₂O

23. (a) : Magnetic moment (μ) = $\sqrt{n(n+2)}$

where n = number of unpaired electrons.

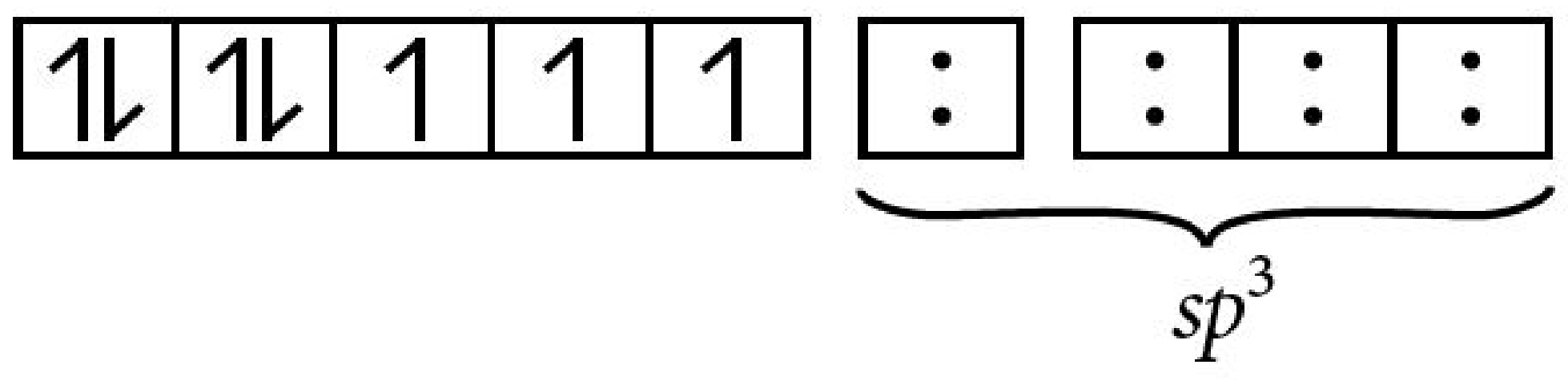
i.e., greater the number of unpaired electrons, greater will be the paramagnetic character.

$[MnCl_4]^{2-}\rightarrow$



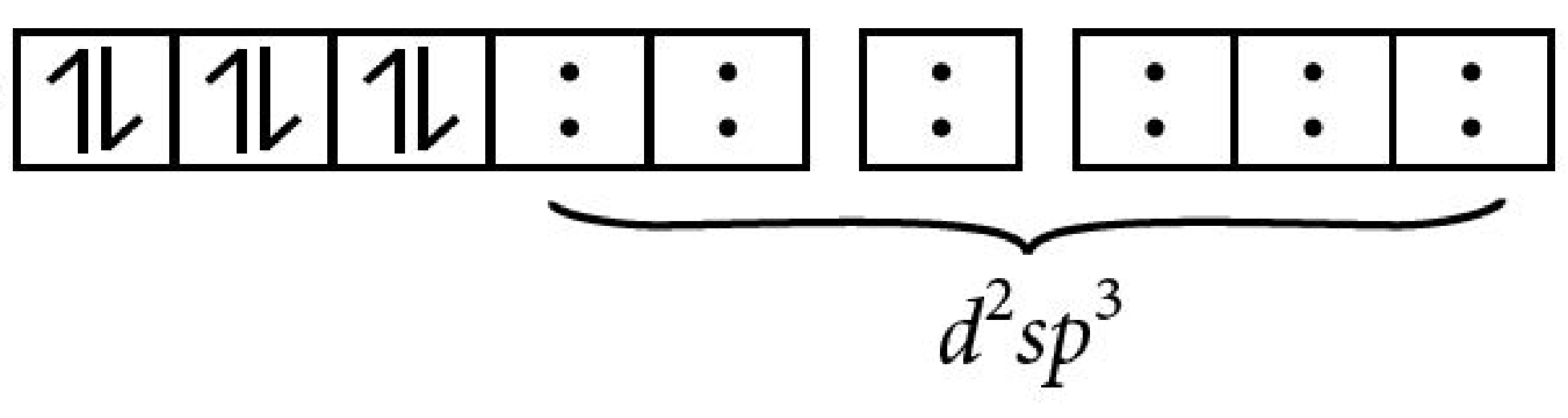
Number of unpaired electrons = 5, (μ = 5.9 B.M.)

$[CoCl_4]^{2-}\rightarrow$



Number of unpaired electrons = 3, (μ = 3.8 B.M.)

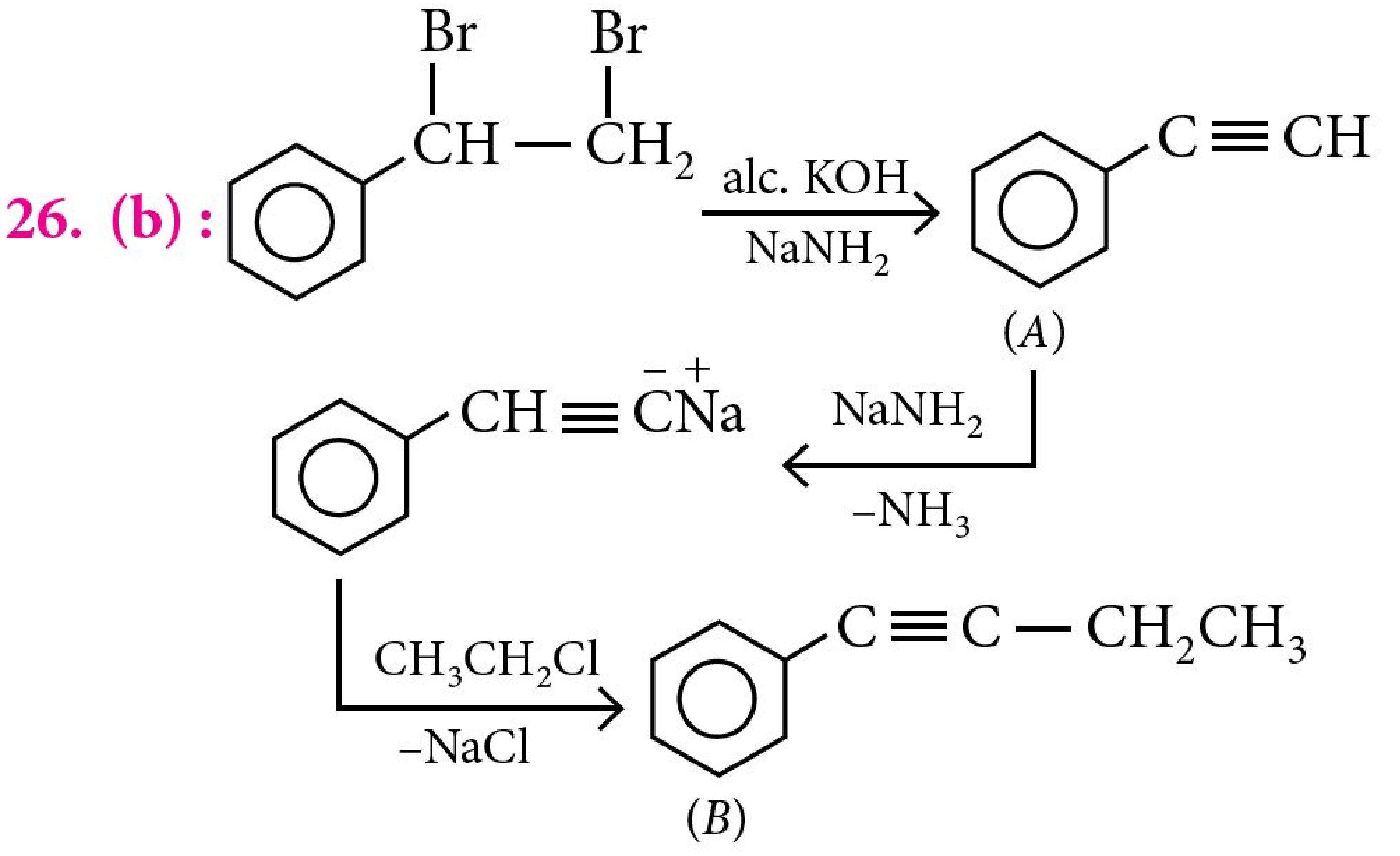
$[Fe(CN)_6]^{4-}\rightarrow$



Number of unpaired electrons = 0, (μ = 0 B.M.)

24. (b) **25. (a)**

26. (b) :

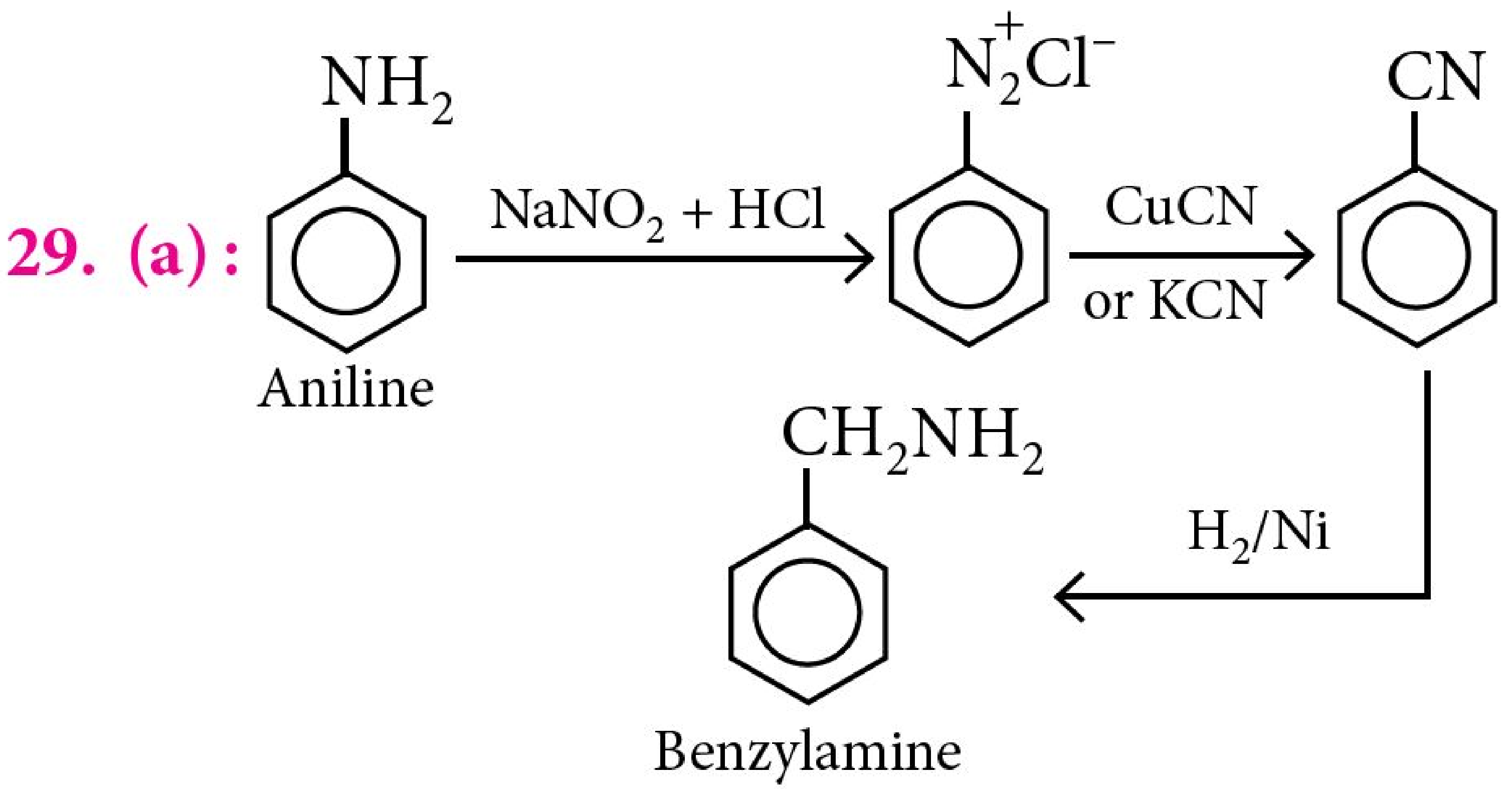

alc. KOH
NaNH₂
(A)
NaNH₂
−NH₃
CH₃CH₂Cl
−NaCl
(B)

27. (c) : They lie in the reactivity series as Zn > Cu > Ag.

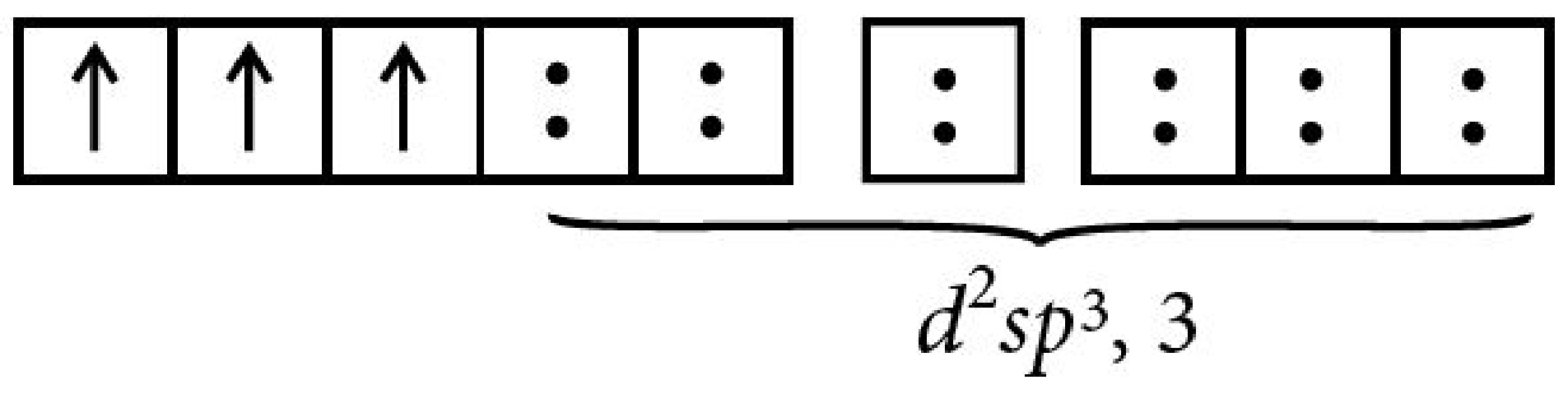
28. (a) :

$$\begin{tikzcd}
CH_3CH(OH)CH_3 \arrow[r, "\text{Conc. }H_2SO_4", "\text{Heat}"'] & \underset{(X)}{CH_3CH{=}CH_2} \arrow[d, "\text{dil. }H_2SO_4,\ H_2O"] \\
\underset{(Y)}{CH_3CH(OH)CH_3} & \arrow[l]
\end{tikzcd}$$

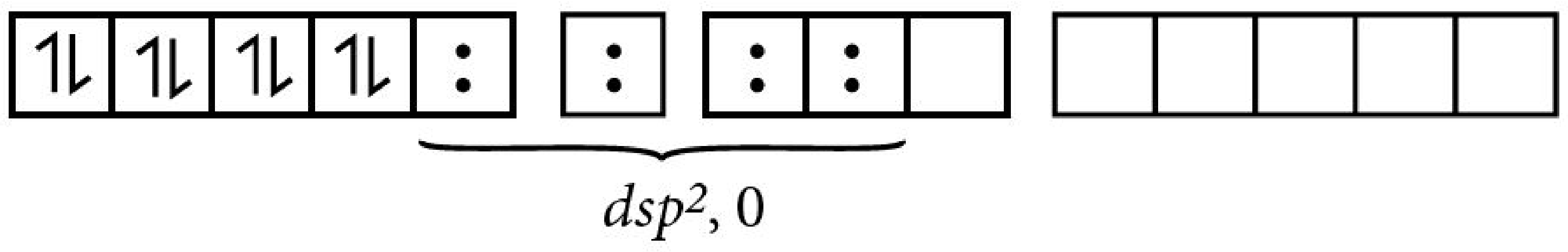
29. (a) :


Aniline
NaNO₂ + HCl
CuCN
or KCN
H₂/Ni
Benzylamine

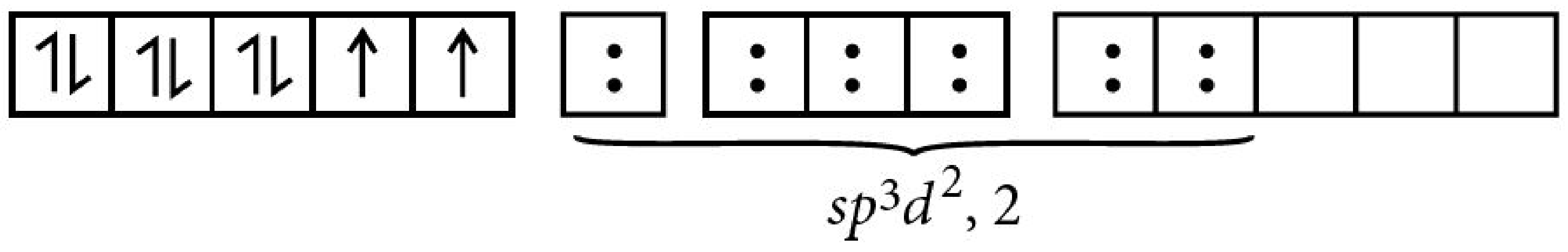
30. (a) : $[Cr(NH_3)_6]^{3+}$:



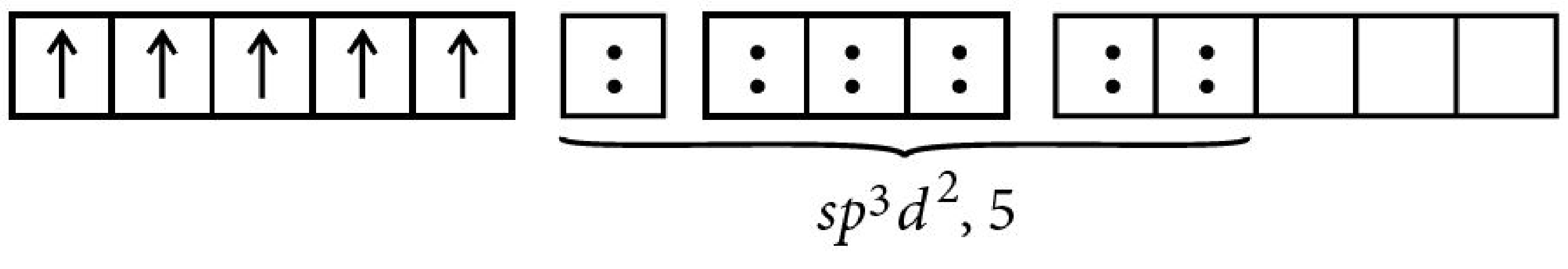
$[Ni(CN)_4]^{2-}$:



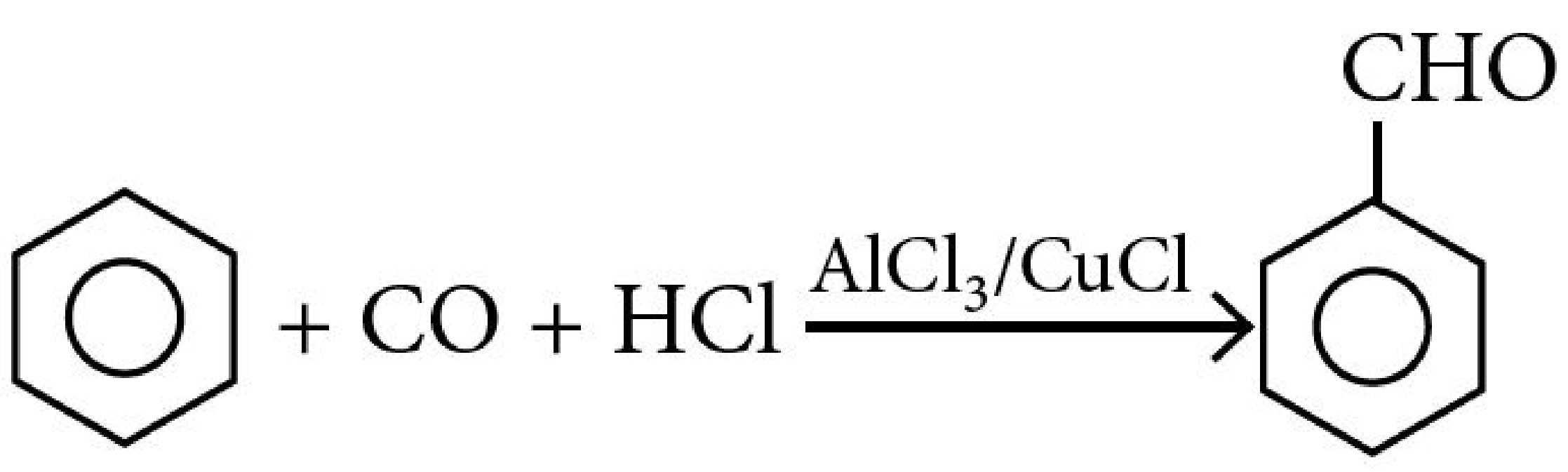
$[Ni(NH_3)_6]^{2+}$:



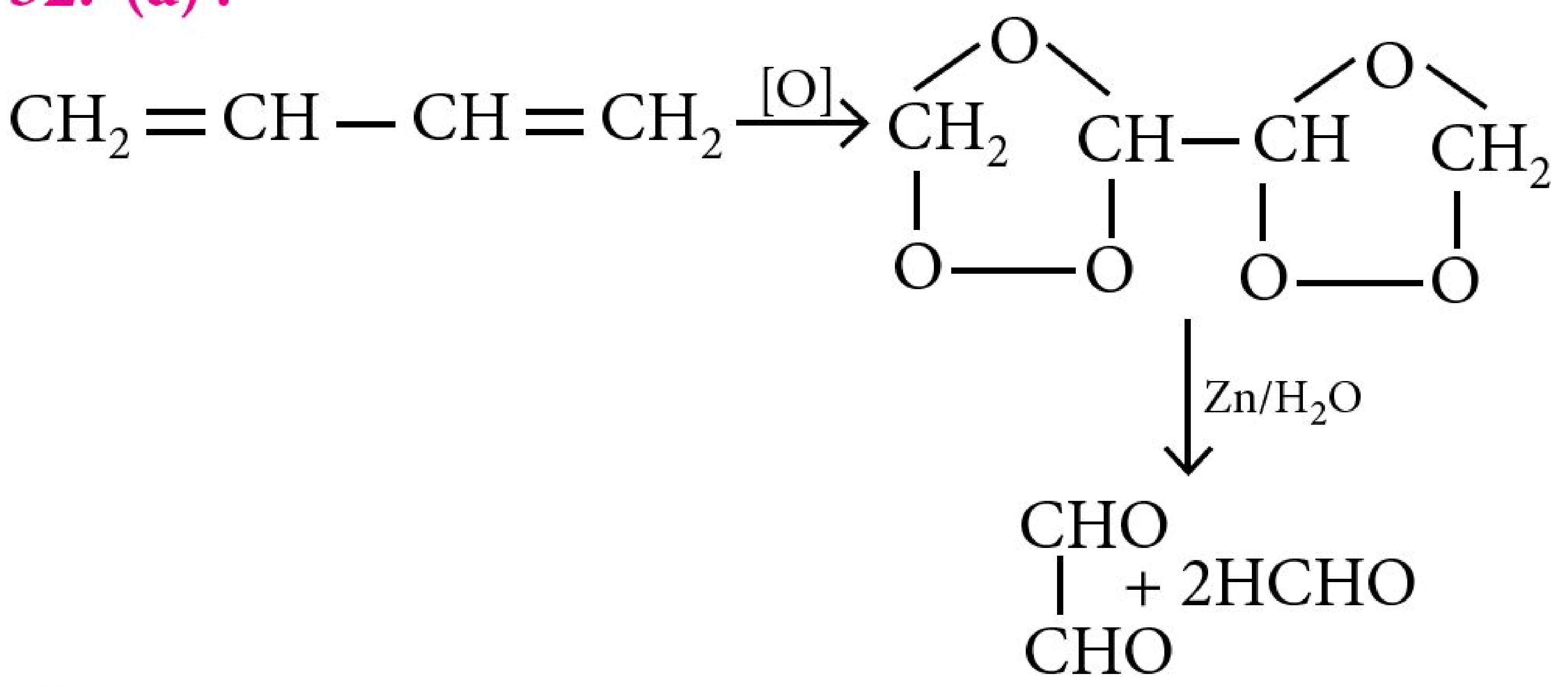
$[MnF_6]^{4-}$:



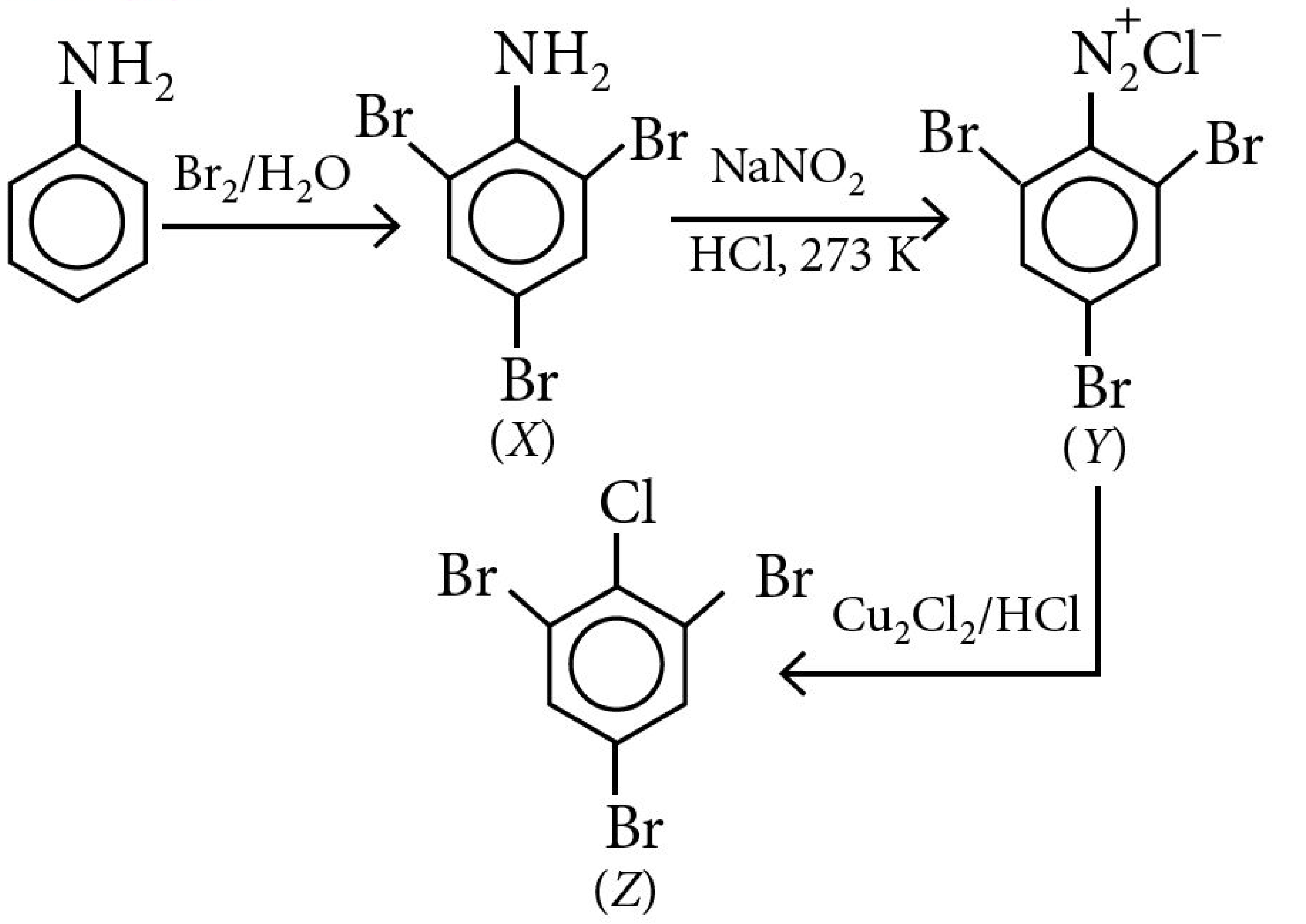
31. (b) : Benzaldehyde can be prepared from benzene by passing vapours of CO and hydrochloric acid in its solution in presence of catalytic mixture of $AlCl_3/CuCl$. The reaction is known as Gattermann–Koch reaction.


+ CO + HCl
AlCl₃/CuCl
CHO

32. (a) :



33. (b) :



34. (c) : Spectrochemical series :

$I^- < Br^- < SCN^- < Cl^- < S^{2-} < F^- < OH^- < C_2O_4^{2-} < O^{2-} < H_2O < NCS^- < EDTA^{4-} < NH_3 < en < NO_2^- < CN^- < CO$

35. (b)

36. (a) : When $\Delta_o > P$, the electrons paired up in the t_{2g} level rather than going to the e_g level, so when $\Delta_o > P : t_{2g}^4 e_g^0$ and $\Delta_o < P : t_{2g}^3 e_g^1$

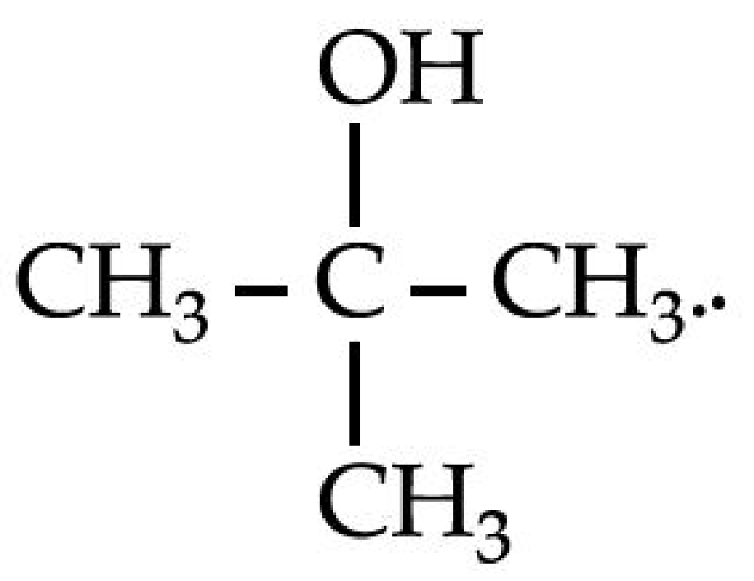
37. (a) : In $[Ti(H_2O)_6]^{3+}$, Ti is in +3 oxidation state and there is only one electron in d-orbital.

38. (d) : $Fe^{2+} : 3d^6 \Rightarrow t_{2g}^4 e_g^2$

Since, F^- is a weak field ligand hence, four unpaired electrons are present. Magnetic moment (μ)

$$= \sqrt{n(n+2)} = \sqrt{4(4+2)} = 4.9 \text{ B.M.}$$

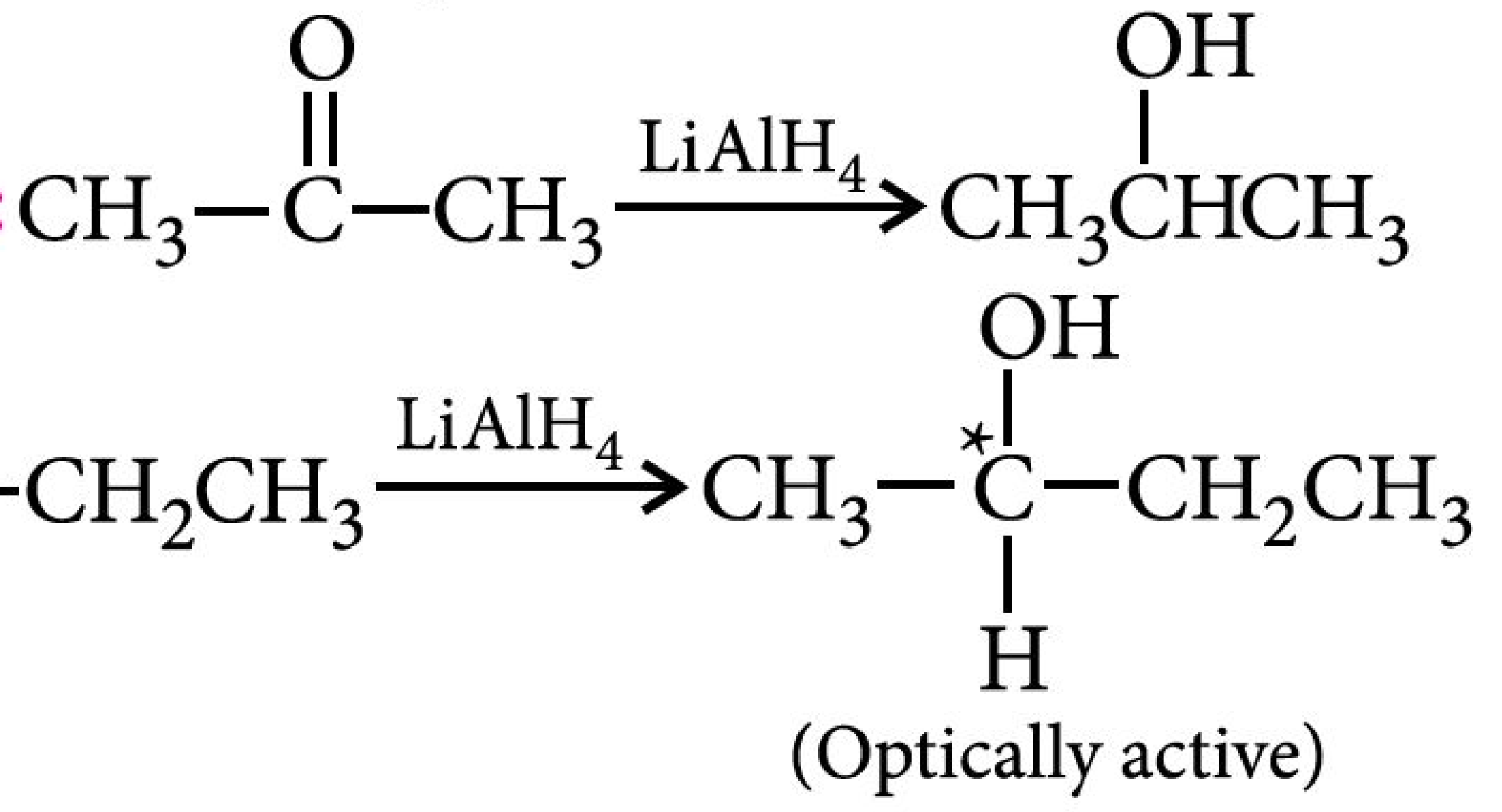
39. (d) : 2-Methyl-2-propanol is



$CH_3-\underset{CH_3}{\overset{OH}{C}}-CH_3$.

It cannot be obtained by reduction of an aldehyde or ketone with $NaBH_4$.

40. (b) :



$$CH_3-\overset{O}{\overset{\|}{C}}-CH_3 \xrightarrow{LiAlH_4} CH_3\overset{OH}{\overset{|}{C}}HCH_3$$

$$CH_3\overset{O}{\overset{\|}{C}}-CH_2CH_3 \xrightarrow{LiAlH_4} CH_3-\underset{H}{\overset{OH}{\overset{*}{C}}}-CH_2CH_3$$

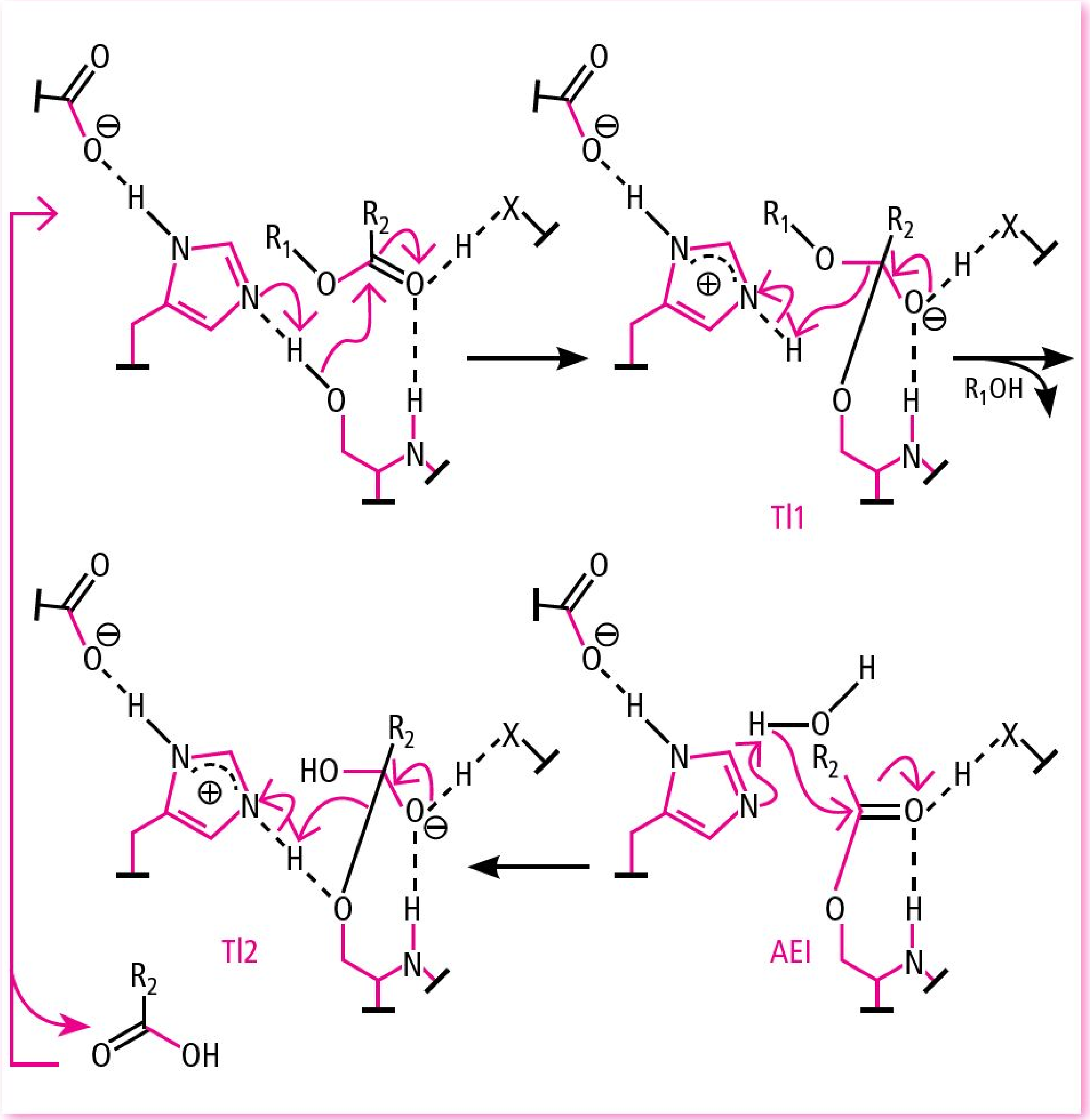
(Optically active)

Chemistry bulletin

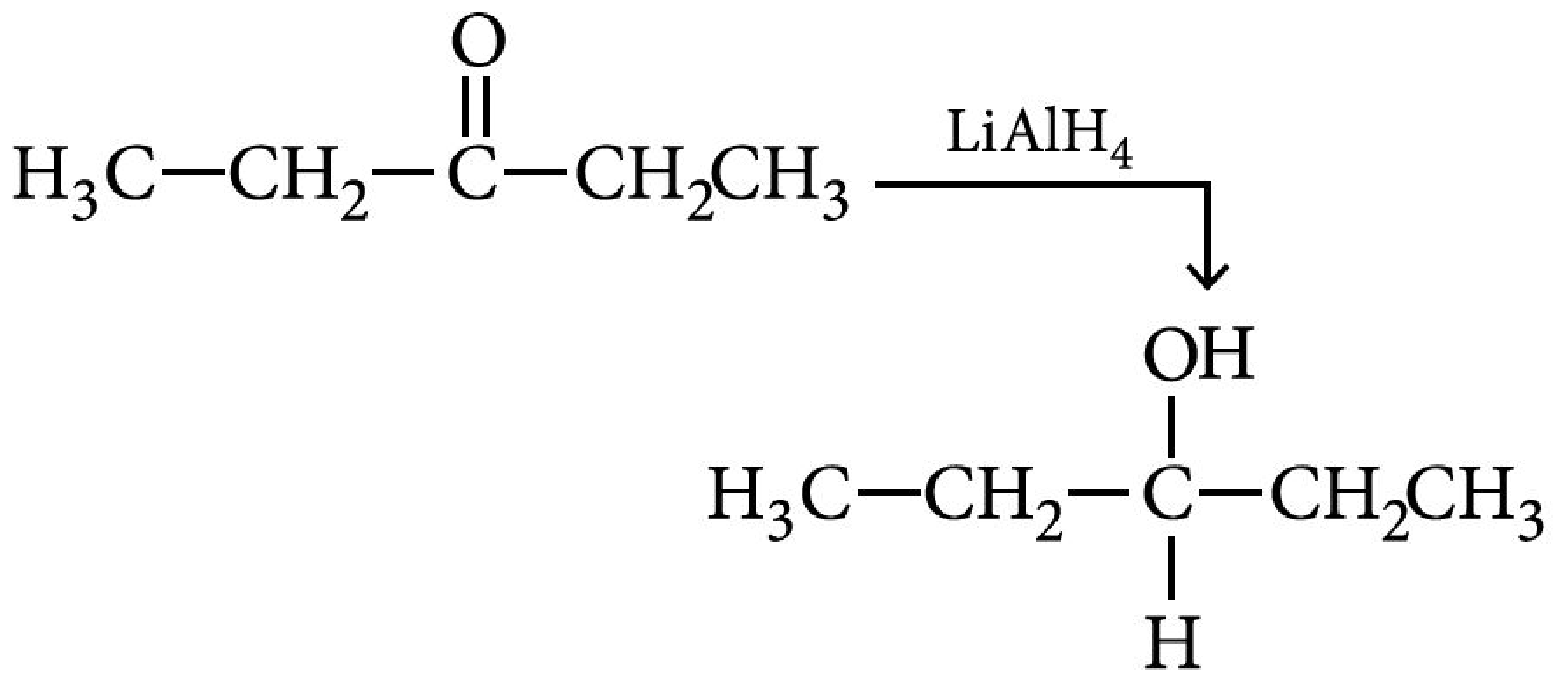
Designer protein performs multi-step catalysis with life-like performance

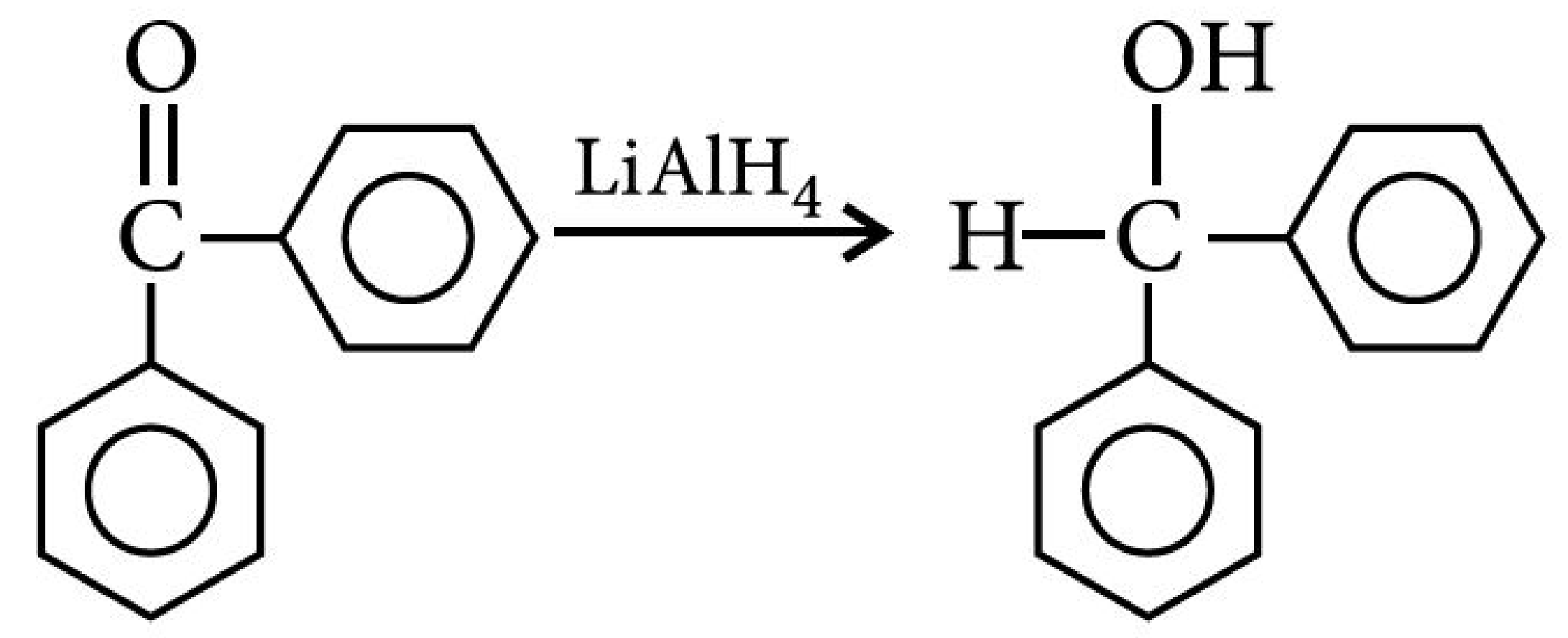
A synthetic hydrolase enzyme with activity comparable to natural proteins has been designed from scratch using a combination of generative AI techniques. Synthetic proteins that promote multi-step catalysis have previously proven challenging to engineer. But the team behind this work, led by 2024 Nobel prize winner David Baker, believes that its approach will enable the design of new enzymes capable of performing a range of complex transformations.

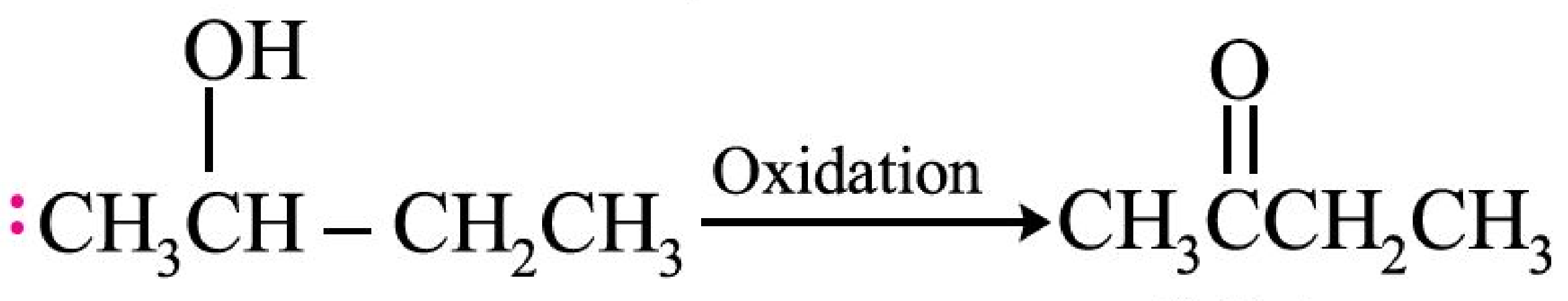
The precise order and orientation of amino acids within the active site enables enzymes to control chemical reactions with an efficiency and specificity that synthetic chemists can only dream of. 'We want to harness their chemical power on demand,' says Anna Lauko, a postdoctoral researcher in the Baker lab. 'If we could design them systematically, we could potentially create new solutions to some of the most pressing modern challenges.'



Current enzyme engineering approaches generally involve placing key active residues within a fixed protein scaffold, using molecular dynamics simulations to predict the reaction performance. However, these protein designs fail to adapt to the differing needs of each stage in the reaction mechanism, often leading to the reaction stalling at an intermediate step.





41. (b): 

$$CH_3\overset{OH}{CH}-CH_2CH_3 \xrightarrow{\text{Oxidation}} CH_3\overset{O}{C}CH_2CH_3$$

2-Butanol ($C_4H_{10}O$) 2-Butanone

2-Butanone forms oxime on reaction with hydroxylamine (NH_2OH) and also gives positive iodoform test.

42 (b): Since the compound does not reduce Fehling's solution but forms crystalline bisulphite derivative hence it is a ketone. Since it gives iodoform test, the compound can be a methyl ketone. Hence, the possible compounds can be 2-pentanone and 3-methyl-2-butanone.

43. (a): This reaction is Wolff-Kishner reduction. The reagents used for this reduction are NH_2NH_2/KOH.

44. (c)

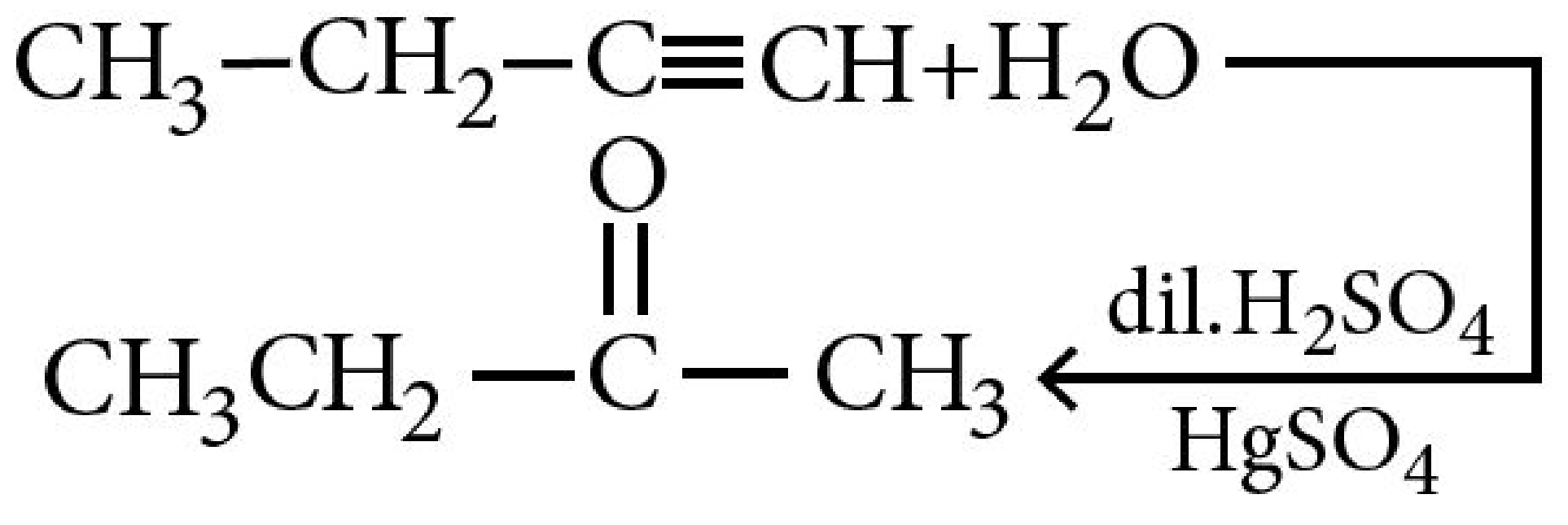
45. (a): At anode : $2Br^- \rightarrow Br_2 + 2e^-$

At cathode : $2H^+ + 2e^- \rightarrow H_2$

Net reaction : $2H^+ + 2Br^- \rightarrow Br_2 + H_2$

Nernst equation for the given cell,

$$E_{cell} = E^\circ_{cell} - \frac{0.0591}{2}\log\frac{[Br_{2(l)}][H_2]}{[H^+]^2[Br^-]^2}$$

46. (b): 

$$CH_3-CH_2-C\equiv CH + H_2O \xrightarrow[HgSO_4]{dil.H_2SO_4} CH_3CH_2-\overset{O}{C}-CH_3$$

47. (b): The oxidation states of various metals are

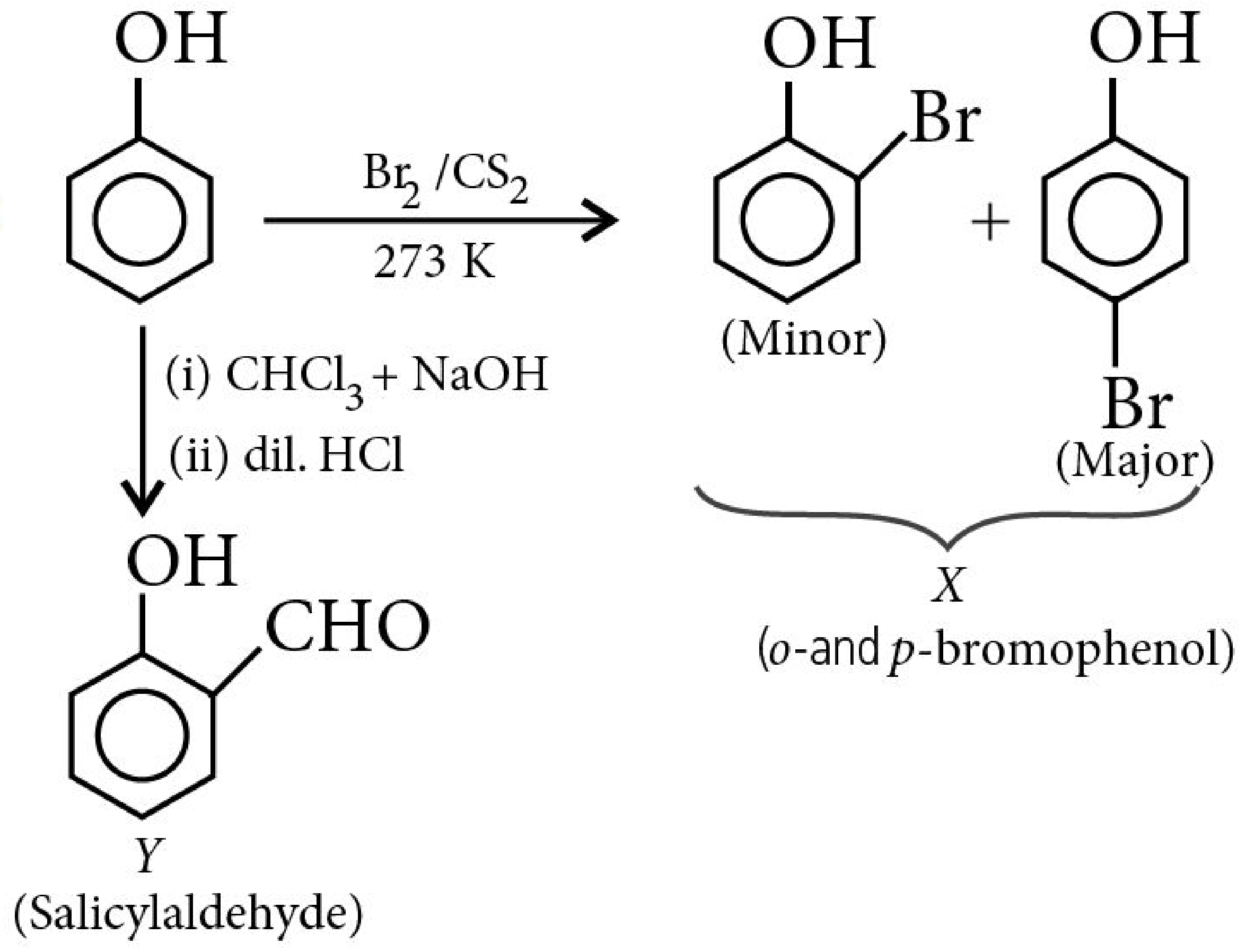
$[Cr(H_2O)_6]^{3+}$; Cr^{3+} *i.e.,* $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^3$
i.e., 3 unpaired electrons

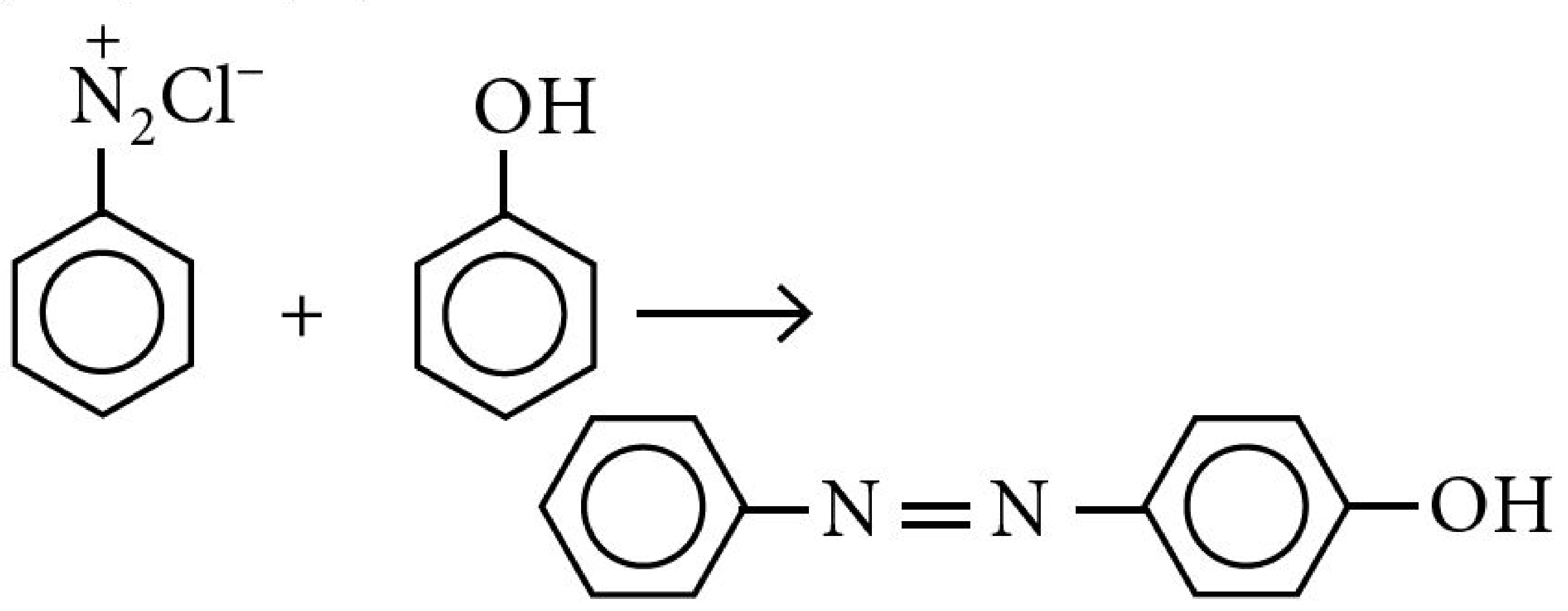
$[Fe(H_2O)_6]^{2+}$; Fe^{2+} *i.e.,* $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^6$
i.e., 4 unpaired electrons

$[Cu(H_2O)_6]^{2+}$; Cu^{2+} *i.e.,* $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^9$
i.e., 1 unpaired electron

$[Zn(H_2O)_6]^{2+}$; Zn^{2+} *i.e.,* $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}$
i.e., no unpaired electron

Thus, highest paramagnetism will be shown by $[Fe(H_2O)_6]^{2+}$ in which we have 4 unpaired *d*-electrons (maximum number of unpaired electrons).

48. (b): 

49. (a): 

p-Hydroxyazobenzene

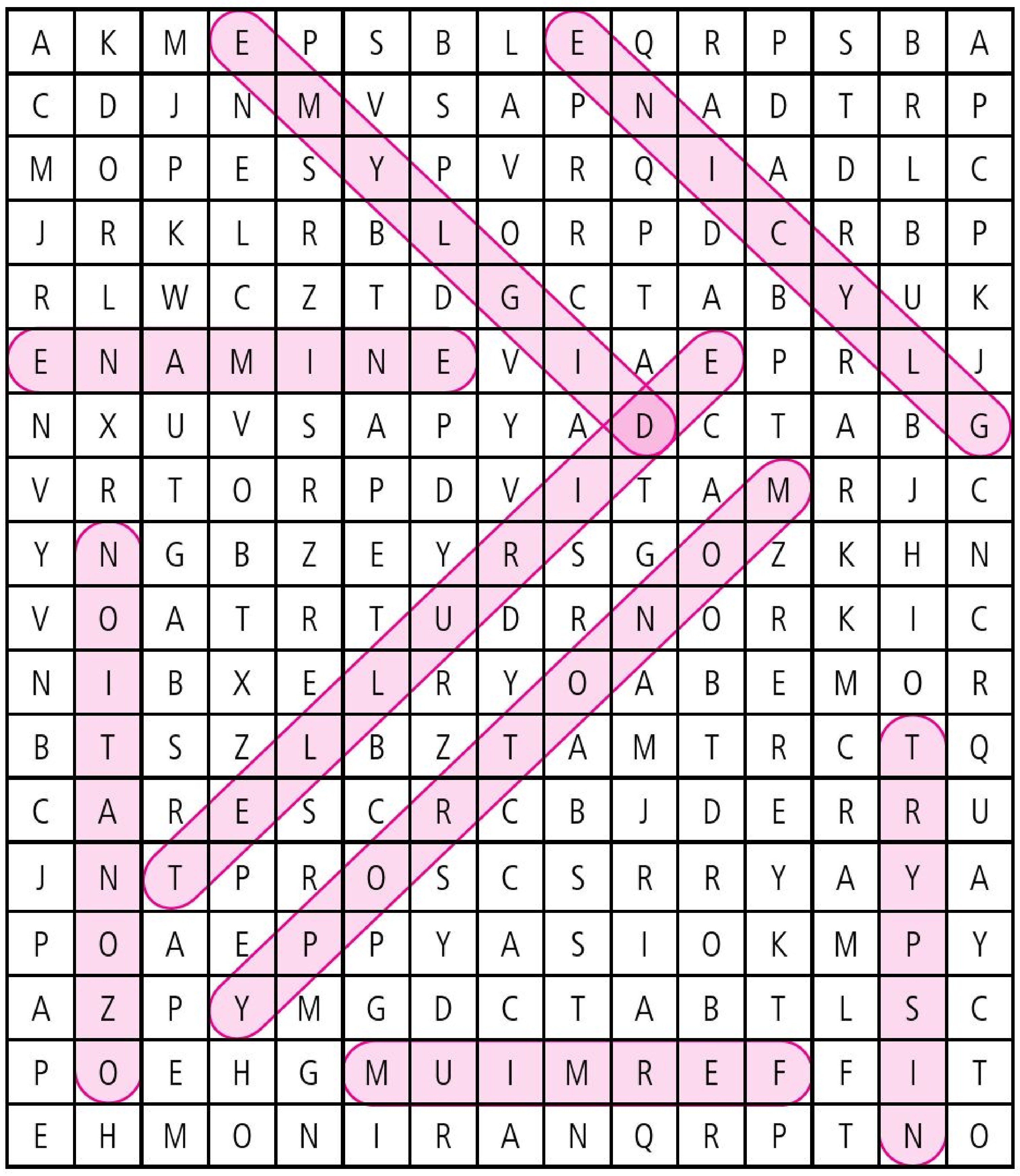
This reaction is called coupling reaction.

50. (a)

◆

***Winners** : Kritika, Neeraj*

SOLUTIONS TO APRIL 2025 WORD GRID



A	K	M	E	P	S	B	L	E	Q	R	P	S	B	A
C	D	J	N	M	V	S	A	P	N	A	D	T	R	P
M	O	P	E	S	Y	P	V	R	Q	I	A	D	L	C
J	R	K	L	R	B	L	O	R	P	D	C	R	B	P
R	L	W	C	Z	T	D	G	C	T	A	B	Y	U	K
E	N	A	M	I	N	E	V	I	A	E	P	R	L	J
N	X	U	V	S	A	P	Y	A	D	C	T	A	B	G
V	R	T	O	R	P	D	V	I	T	A	M	R	J	C
Y	N	G	B	Z	E	Y	R	S	G	O	Z	K	H	N
V	O	A	T	R	T	U	D	R	N	O	R	K	I	C
N	I	B	X	E	L	R	Y	O	A	B	E	M	O	R
B	T	S	Z	L	B	Z	T	A	M	T	R	C	T	Q
C	A	R	E	S	C	R	C	B	J	D	E	R	R	U
J	N	T	P	R	O	S	C	S	R	R	Y	A	Y	A
P	O	A	E	P	P	Y	A	S	I	O	K	M	P	Y
A	Z	P	Y	M	G	D	C	T	A	B	T	L	S	C
P	O	E	H	G	M	U	I	M	R	E	F	F	I	T
E	H	M	O	N	I	R	A	N	Q	R	P	T	N	O

1.	Trypsin	5.	Diglyme
2.	Fermium	6.	Enamine
3.	Ozonation	7.	Monotropy
4.	Glycine	8.	Telluride

PRACTICE PAPER 2025
BITSAT

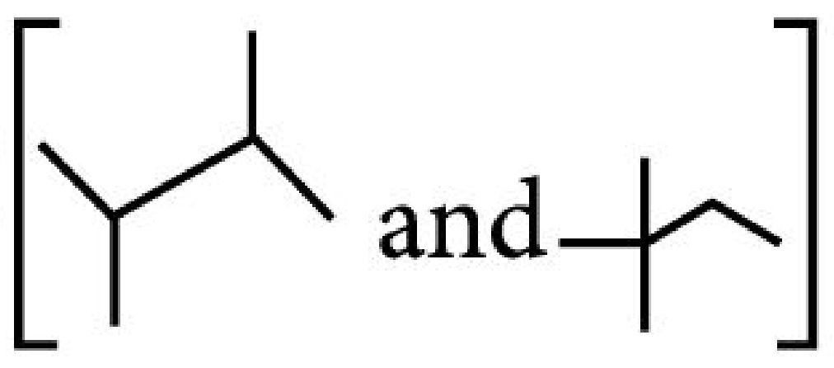
Exam Dates
Session-I
26th May to 30th May
Session-II
22nd June to 26th June

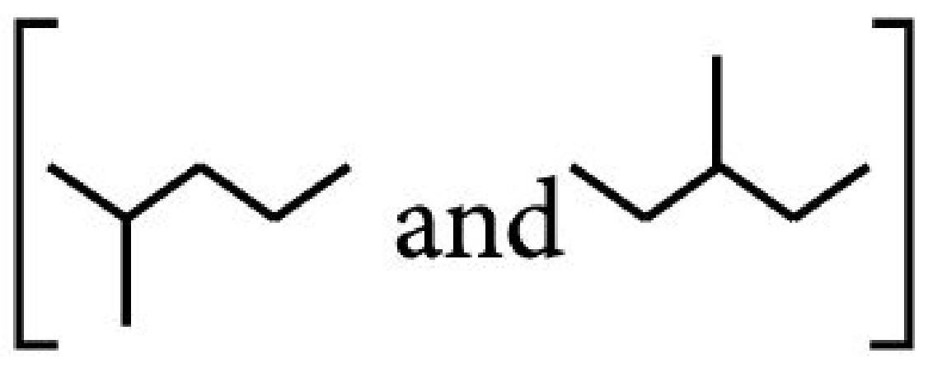
1. At a given temperature T, gases Ne, Ar, Xe and Kr are found to deviate from ideal gas behaviour. Their equation of state is given as $p=\dfrac{RT}{V-b}$ at T.
Here, b is the van der Waals' constant. Which gas will exhibit steepest increase in the plot of Z (compression factor) *vs* p?
(a) Xe (b) Ne (c) Ar (d) Kr

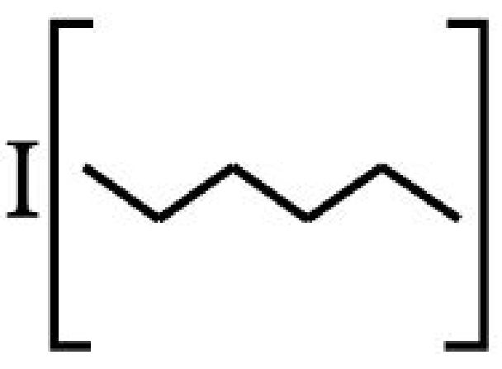
2. For the following electrochemical cell at 298 K,
$$\text{Pt}_{(s)}|\text{H}_{2(g)},(1\,\text{bar})|\text{H}^+_{(aq)},(1\,\text{M})||M^{4+}_{(aq)}|M^{2+}_{(aq)}|\text{Pt}_{(s)}$$
$$E_{\text{cell}}=0.092\text{ V when }\frac{[M^{2+}_{(aq)}]}{[M^{4+}_{(aq)}]}=10^x$$
$$\text{Given : }E^\circ_{M^{4+}/M^{2+}}=0.151\text{ V};\ 2.303\frac{RT}{F}=0.059\text{ V}$$
The value of x is
(a) −2 (b) −1 (c) 1 (d) 2

3. Consider the following changes :
$$\boxed{\begin{array}{c}\text{1 kg water}\\ \text{liquid at 25 °C}\end{array}}\xrightarrow{\Delta H_1}\boxed{\begin{array}{c}\text{1 kg water}\\ \text{liquid at 100 °C}\end{array}}\xrightarrow{\Delta H_2}\boxed{\begin{array}{c}\text{1 kg water}\\ \text{steam at 100 °C}\end{array}}$$
(Given : Specific heat of water = 1 cal/g °C
Latent heat of vaporisation of water = 10 kcal/mol)
ΔH_1 is
(a) 75 kcal (b) 550 kcal (c) 750 kcal (d) 55 kcal

4. Isomers of hexane, based on their branching, can be divided into three distinct classes as shown in the figure.

I 

II 

III 

The correct order of their boiling point is
(a) I > II > III (b) III > II > I
(c) II > III > I (d) III > I > II

5. Diborane is a Lewis acid forming addition compound $B_2H_6\cdot 2NH_3$ with NH_3, a Lewis base, This
(a) is ionic and exists as $[BH_2(NH_3)_2]^+$ and $[BH_4]^-$ ions
(b) on heating, is converted into borazine, $B_3N_3H_6$ (called inorganic benzene)
(c) both are correct
(d) none is correct.

6. Match the column-I with column-II and mark the appropriate choice.

	Column-I		Column-II
(A)	Methanol	(i)	Conversion of phenol to *o*-hydroxysalicylic acid
(B)	Kolbe's reaction	(ii)	Ethyl alcohol
(C)	Williamson's synthesis	(iii)	Conversion of phenol to salicylaldehyde
(D)	Conversion of 1° alcohol to aldehyde	(iv)	Wood spirit
(E)	Reimer-Tiemann reaction	(v)	Heated copper at 573 K
(F)	Fermentation	(vi)	Reaction of alkyl halide with sodium alkoxide

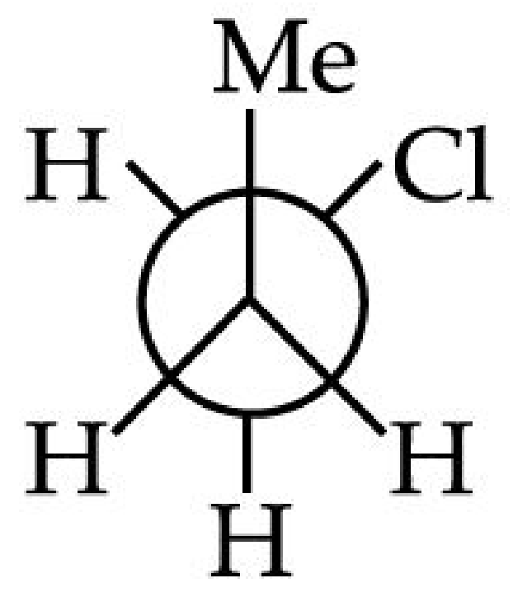
(a) (A) → (ii), (B) → (iv), (C) → (i), (D) → (iii), (E) → (v), (F) → (vi)
(b) (A) → (vi), (B) → (v), (C) → (ii), (D) → (iv), (E) → (i), (F) → (iii)
(c) (A) → (iv), (B) → (i), (C) → (vi), (D) → (v), (E) → (iii), (F) → (ii)
(d) (A) → (v), (B) → (ii), (C) → (iv), (D) → (vi), (E) → (iii), (F) → (i)

7. In a multi-electron atom, which of the following orbitals described by the three quantum numbers will have the same energy in the absence of magnetic and electric fields?

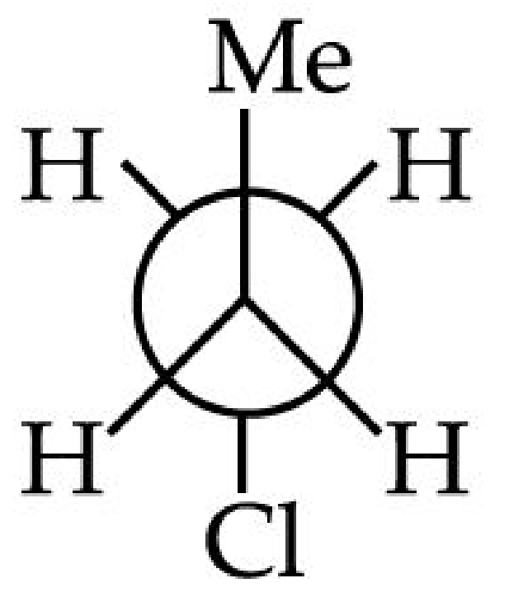
(i) $n = 1, l = 0, m = 0$ (ii) $n = 2, l = 0, m = 0$
(iii) $n = 2, l = 1, m = 1$ (iv) $n = 3, l = 2, m = 1$
(v) $n = 3, l = 2, m = 0$

(a) (i) and (ii) (b) (ii) and (iii)
(c) (iii) and (iv) (d) (iv) and (v)

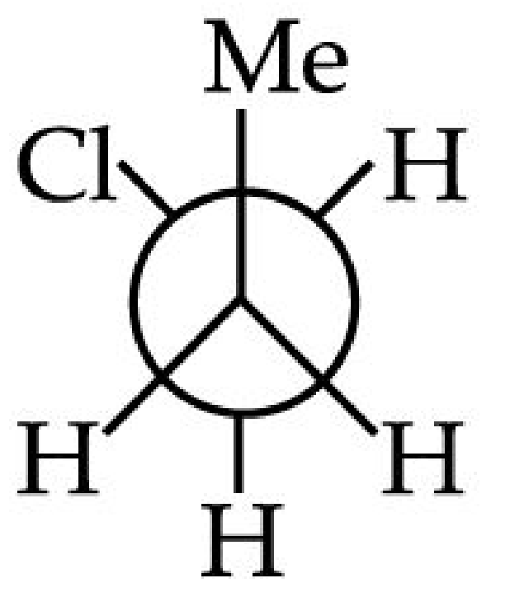
8. Chloropropane can show following conformational isomers.



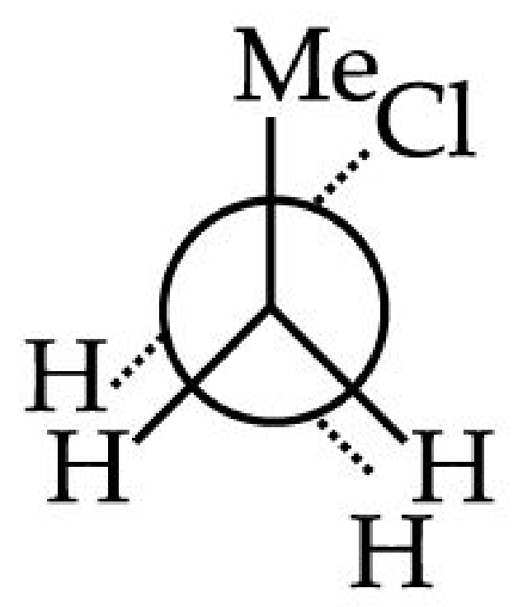
(I)



(II)



(III)



(IV)

Stable conformer among them is

(a) II (b) III (c) I (d) IV

9. An amount of solid NH_4HS is placed in a flask already containing ammonia gas at a certain temperature and 0.50 atm. pressure. Ammonium hydrogen sulphide decomposes to yield NH_3 and H_2S gases in the flask. When the decomposition reaction reaches equilibrium, the total pressure in the flask rises to 0.84 atm. The equilibrium constant for NH_4HS decomposition at this temperature is

(a) 0.30 (b) 0.18 (c) 0.17 (d) 0.11

10. In the coagulation of a positive sol, the flocculation powers of Cl^-, SO_4^{2-}, PO_4^{3-} and $[Fe(CN)_6]^{4-}$ are in the order

(a) $Cl^- > SO_4^{2-} > [Fe(CN)_6]^{4-} > PO_4^{3-}$

(b) $Cl^- > PO_4^{3-} > SO_4^{2-} > [Fe(CN)_6]^{4-}$

(c) $[Fe(CN)_6]^{4-} > PO_4^{3-} > SO_4^{2-} > Cl^-$

(d) $Cl^- > SO_4^{2-} > PO_4^{3-} > [Fe(CN)_6]^{4-}$

11. Which of the following does not represent the correct order of the property indicated?

(a) $Sc^{3+} > Cr^{3+} > Fe^{3+} > Mn^{3+}$: Ionic radii
(b) $Sc < Ti < Cr < Mn$: Density
(c) $Ni^{2+} < Co^{2+} < Fe^{2+} < Mn^{2+}$: Ionic radii
(d) $FeO < CaO > MnO > CuO$: Basic nature

12. Which of the following statements is false?

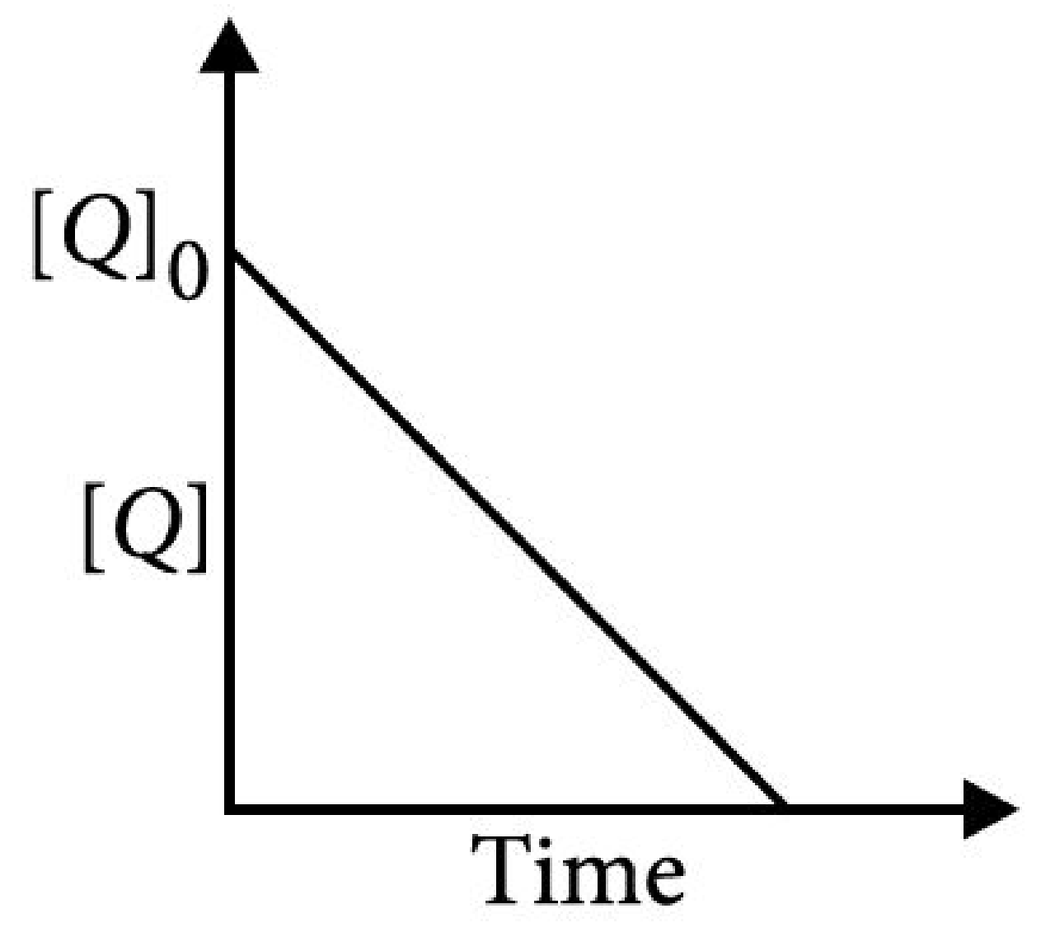
(a) The main reason for river water pollution is industrial and domestic sewage discharge.
(b) Surface water contains a lot of organic matter, mineral nutrients and radioactive materials.
(c) Oil spill in sea water causes heavy damage to fishery.
(d) Oil slick in sea water increases D.O. (dissolved oxygen) value.

13. Match the column-I with column-II and mark the appropriate choice.

Column-I (Property)		**Column-II (Metal)**	
(A)	Element with highest second ionisation enthalpy	(i)	Cr
(B)	Element with highest third ionisation enthalpy	(ii)	Cu
(C)	M in $M(CO)_6$ is	(iii)	Zn
(D)	Element with highest heat of atomisation	(iv)	Ni

(a) (A) → (ii), (B) → (iii), (C) → (i), (D) → (iv)
(b) (A) → (iv), (B) → (iii), (C) → (i), (D) → (ii)
(c) (A) → (iii), (B) → (i), (C) → (ii), (D) → (iv)
(d) (A) → (i), (B) → (ii), (C) → (iii), (D) → (iv)

14. In the reaction, $P + Q \rightarrow R + S$, the time taken for 75% reaction of P is twice the time taken for 50% reaction of P. The concentration of Q varies with reaction time as shown in the figure. The overall order of the reaction is



(a) 2 (b) 3 (c) 0 (d) 1

15. When sugar 'X' is boiled with dilute H_2SO_4 in alcoholic solution, two isomers 'A' and 'B' are formed. 'A' on oxidation with HNO_3 yields saccharic acid where as 'B' is laevorotatory. The compound 'X' is

(a) maltose (b) sucrose (c) lactose (d) starch.

16. In the separation of Cu^{2+} and Cd^{2+} in 2nd group of qualitative analysis of cations, tetraamminecopper(II) sulphate and tetraamminecadmium(II) sulphate reacts with KCN to form the corresponding cyano complexes. Which one of the following pairs of the complexes and their relative stability enables the separation of Cu^{2+} and Cd^{2+}?

(a) $K_3[Cu(CN)_4]$: more stable and
$K_2[Cd(CN)_4]$: less stable

(b) $K_2[Cu(CN)_4]$: less stable and
$K_2[Cd(CN)_4]$: more stable
(c) $K_2[Cu(CN)_4]$: more stable and
$K_2[Cd(CN)_4]$: less stable
(d) $K_3[Cu(CN)_4]$: less stable and
$K_2[Cd(CN)_4]$: more stable

17. X ml of H_2 gas effuses through a hole in a container in 5 seconds. The time taken for the effusion of the same volume of the gas specified below under identical conditions is

(a) 10 seconds : He
(b) 20 seconds : O_2
(c) 25 seconds : CO
(d) 55 seconds : CO_2

18. The non-breakable plastic household crockery is prepared by using

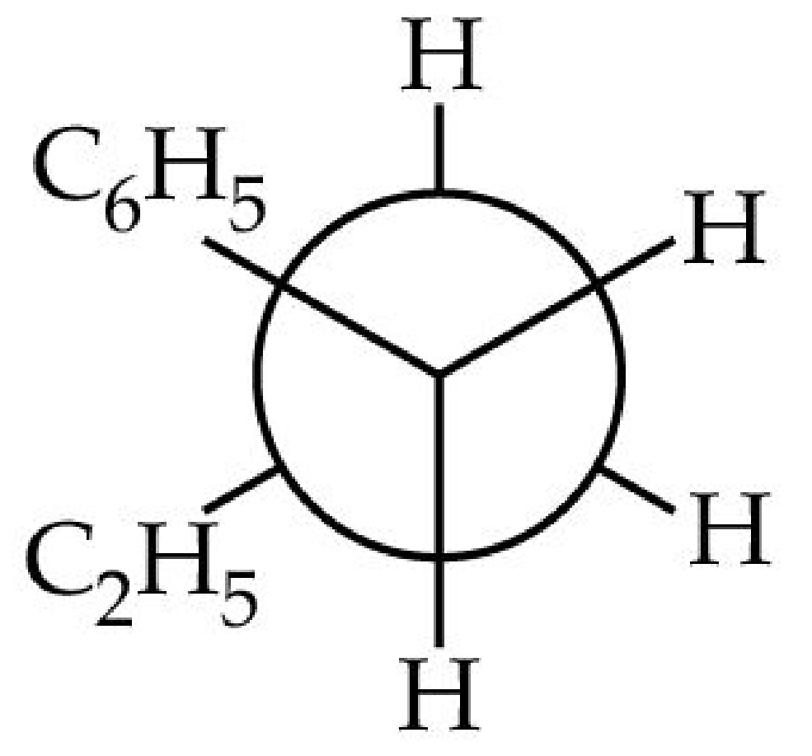
(a) melamine and tetrafluoroethane
(b) malonic acid and hexamethyleneamine
(c) melamine and vinyl acetate
(d) melamine and formaldehyde.

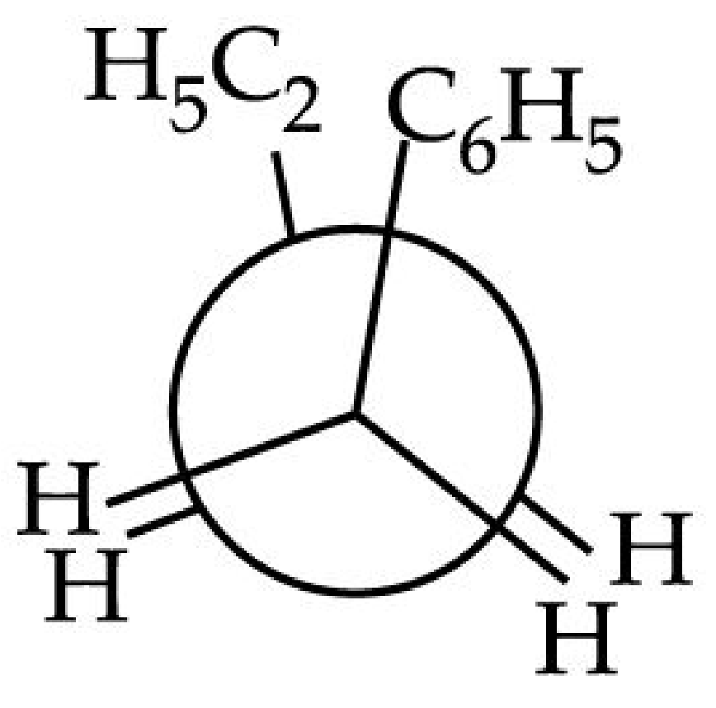
19. Find A, B and C in the following reactions.

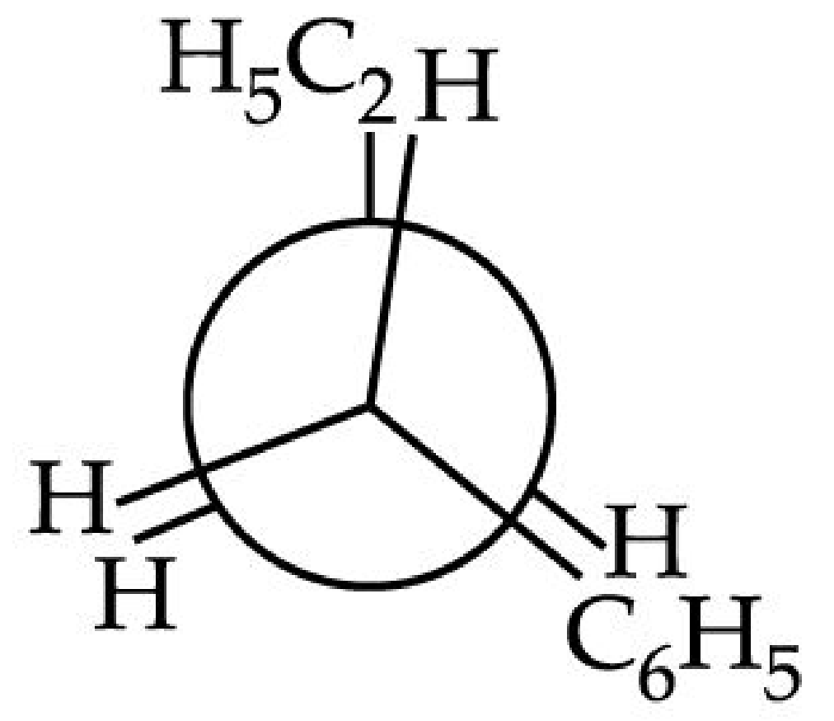
$NH_3 + A + CO_2 \rightarrow (NH_4)_2CO_3$
$(NH_4)_2CO_3 + H_2O + B \rightarrow NH_4HCO_3$
$NH_4HCO_3 + NaCl \rightarrow NH_4Cl + C$

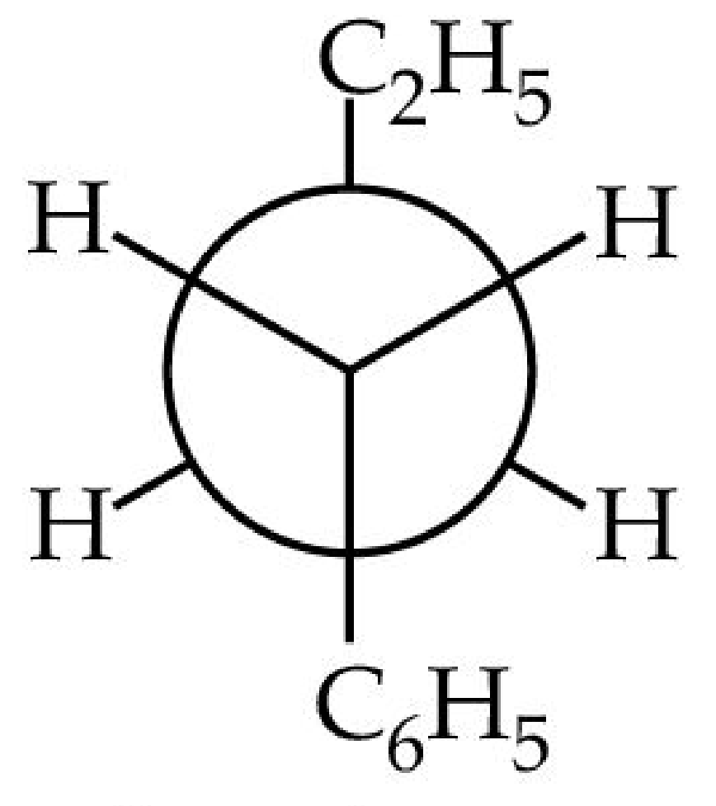
(a) $A - H_2O$; $B - O_2$; $C - Na_2CO_3$
(b) $A - H_2O$; $B - O_2$; $C - NaHCO_3$
(c) $A - O_2$; $B - CO_2$; $C - Na_2CO_3$
(d) $A - H_2O$; $B - CO_2$; $C - NaHCO_3$

20. Which of the following is the most stable conformation of 1-phenyl-2-ethylethane?

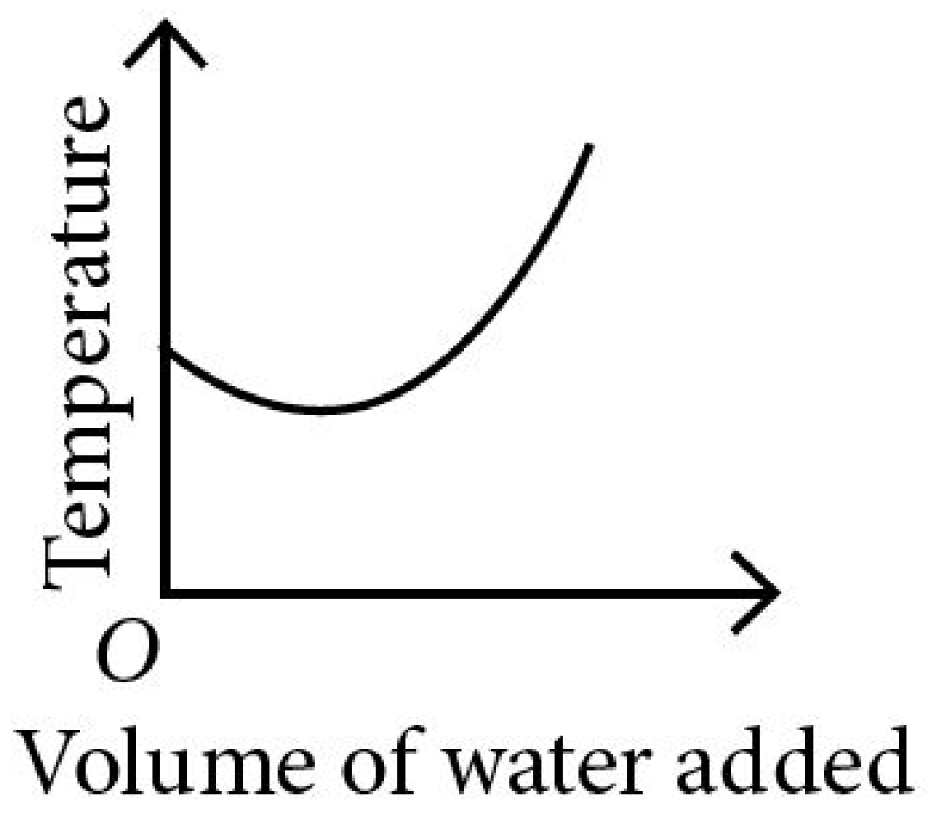
(a)


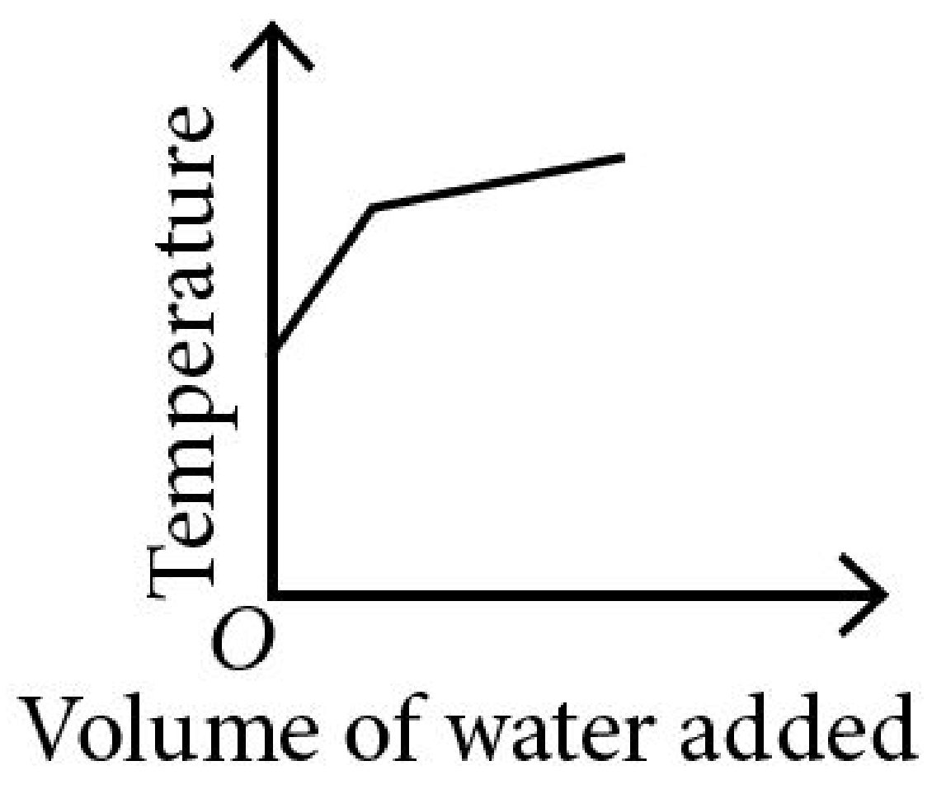
(b)


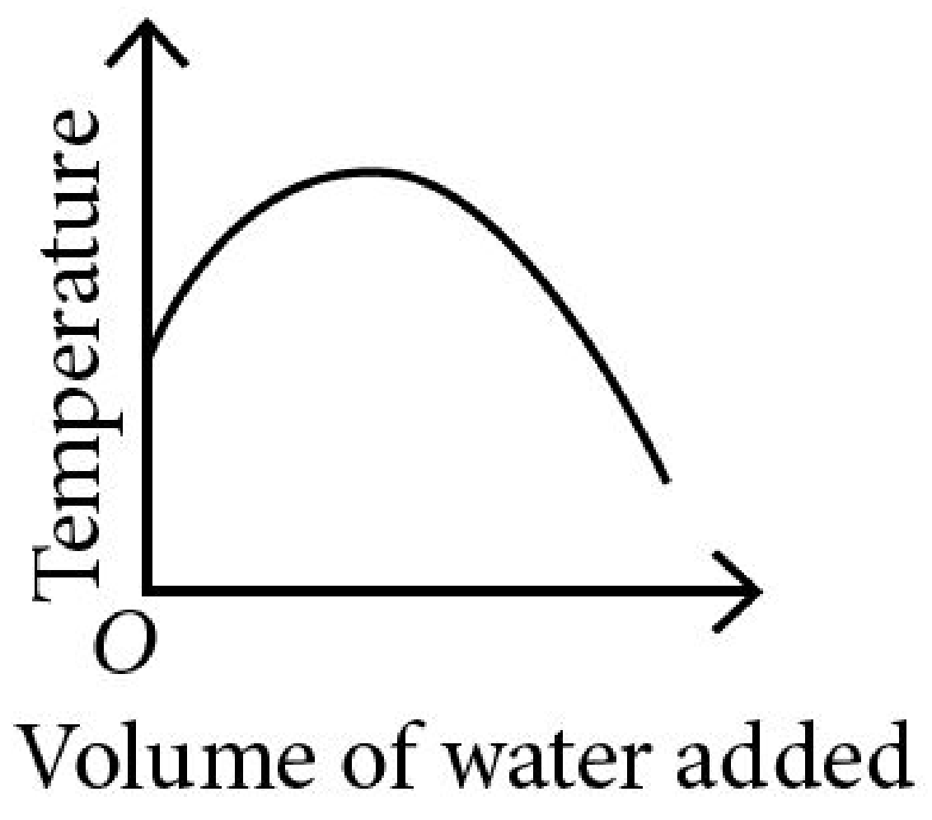
(c)


(d)


21. When water is stirred with glucose, strong hydrogen bonds are initially formed between glucose molecules and water molecules, but as more water is added, these hydrogen bonds are broken. Which graph represents the observed temperature changes?

(a)


(b)


(c)


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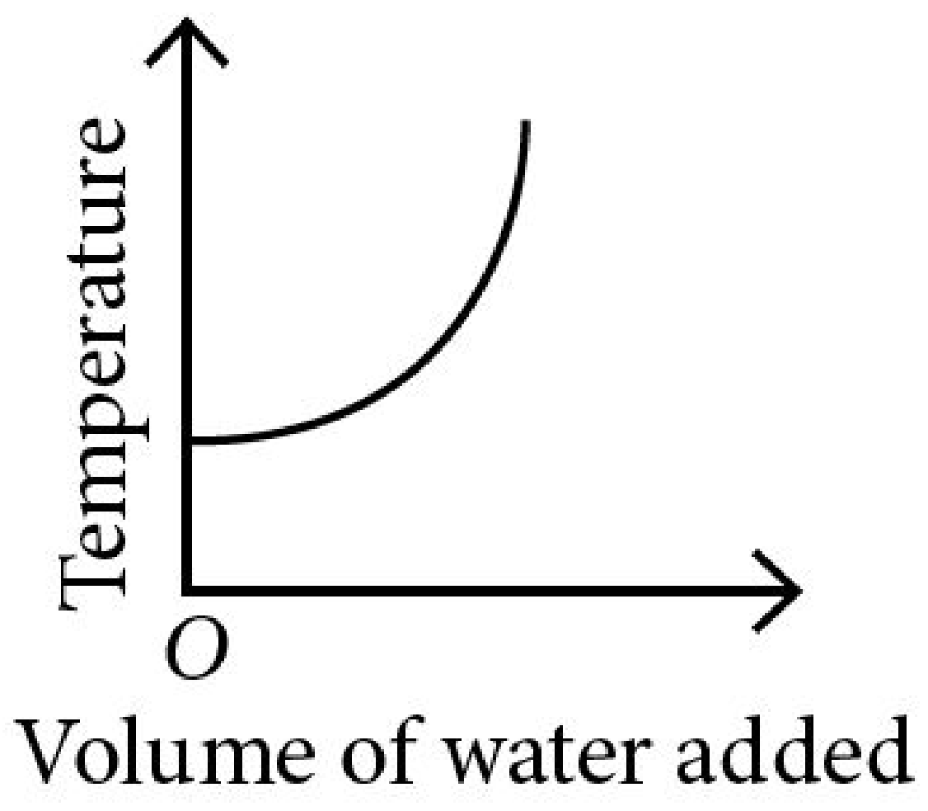
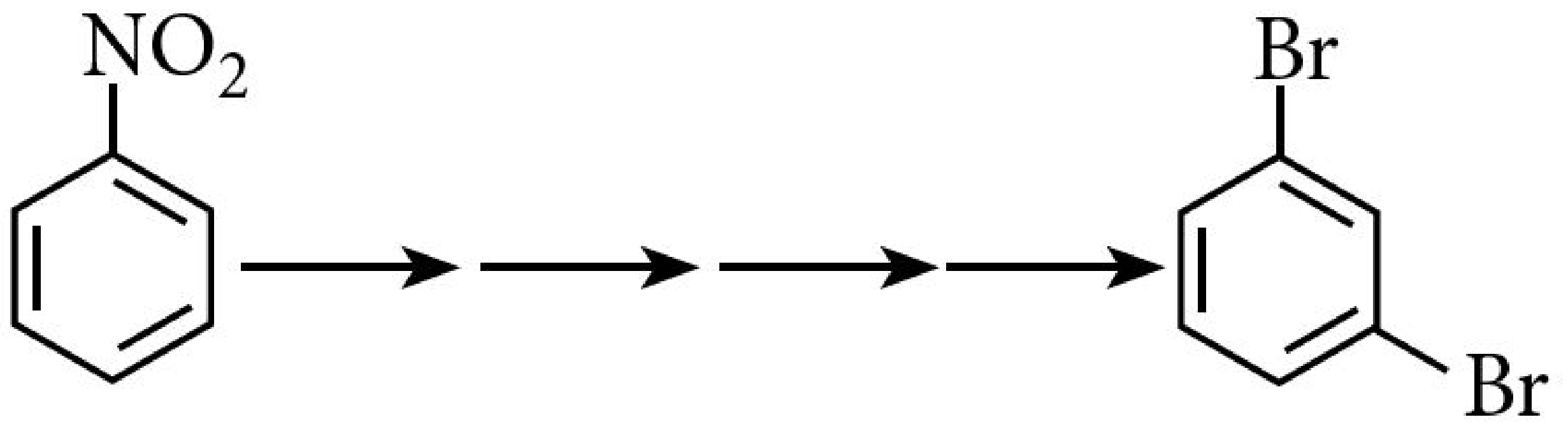
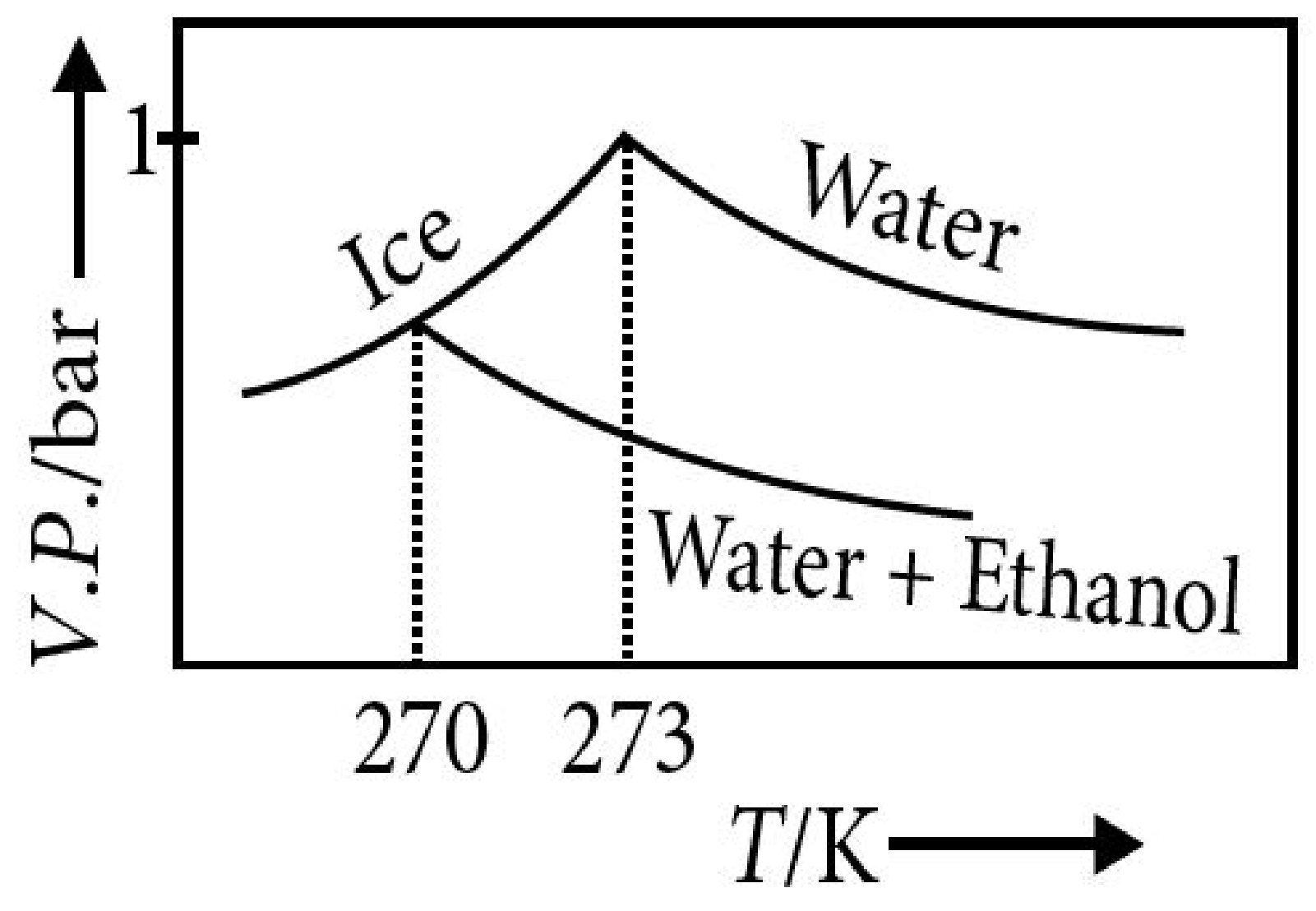


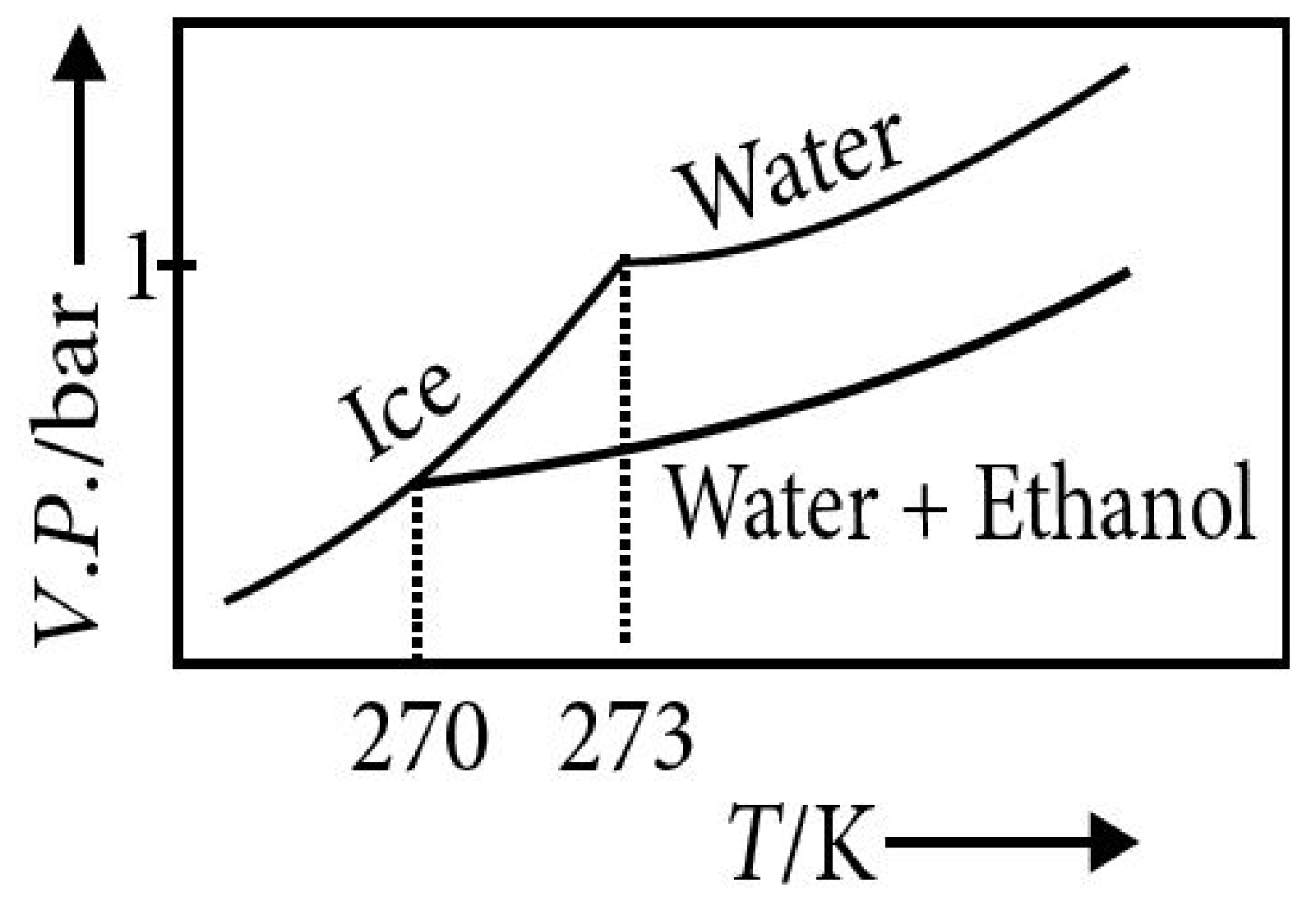
22. What is the correct sequence of reagents used for converting nitrobenzene into m-dibromobenzene?



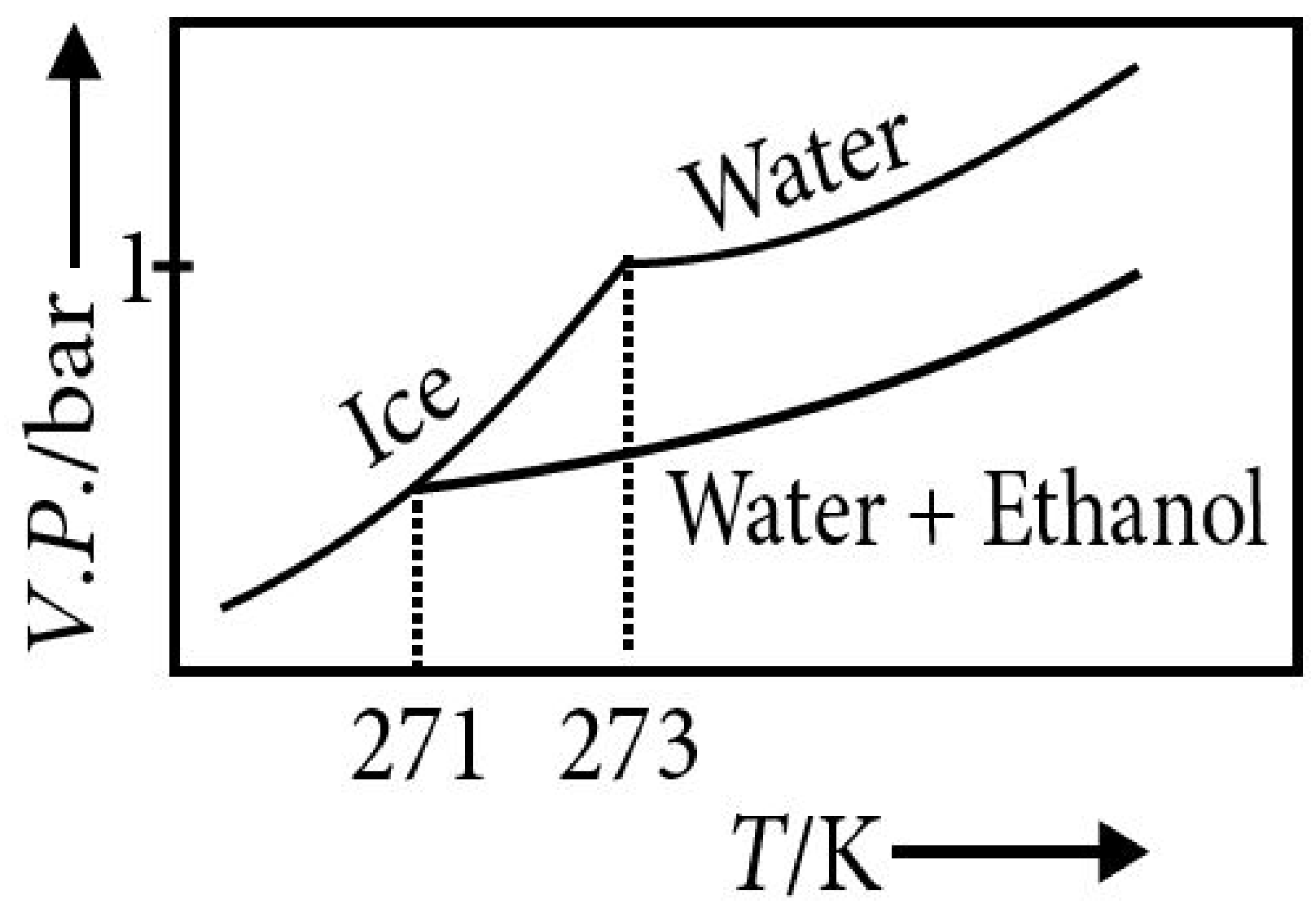
(a) $\xrightarrow{Sn/HCl} / \xrightarrow{KBr} / \xrightarrow{Br_2} / \xrightarrow{H^+}$
(b) $\xrightarrow{Br_2/Fe} / \xrightarrow{Sn/HCl} / \xrightarrow{NaNO_2/HCl} / \xrightarrow{CuBr/HBr}$
(c) $\xrightarrow{NaNO_2} / \xrightarrow{HCl} / \xrightarrow{KBr} / \xrightarrow{H^+}$
(d) $\xrightarrow{Sn/HCl} / \xrightarrow{Br_2} / \xrightarrow{NaNO_2} / \xrightarrow{NaBr}$

23. Pure water freezes at 273 K and 1 bar. The addition of 34.5 g of ethanol to 500 g of water changes the freezing point of the solution. Use the freezing point depression constant of water as 2 K kg mol^{-1}. The figures shown below represent plots of vapour pressure ($V.P.$) versus temperature (T).
[Molecular weight of ethanol is 46 g mol^{-1}]
Among the following, the option representing change in the freezing point is

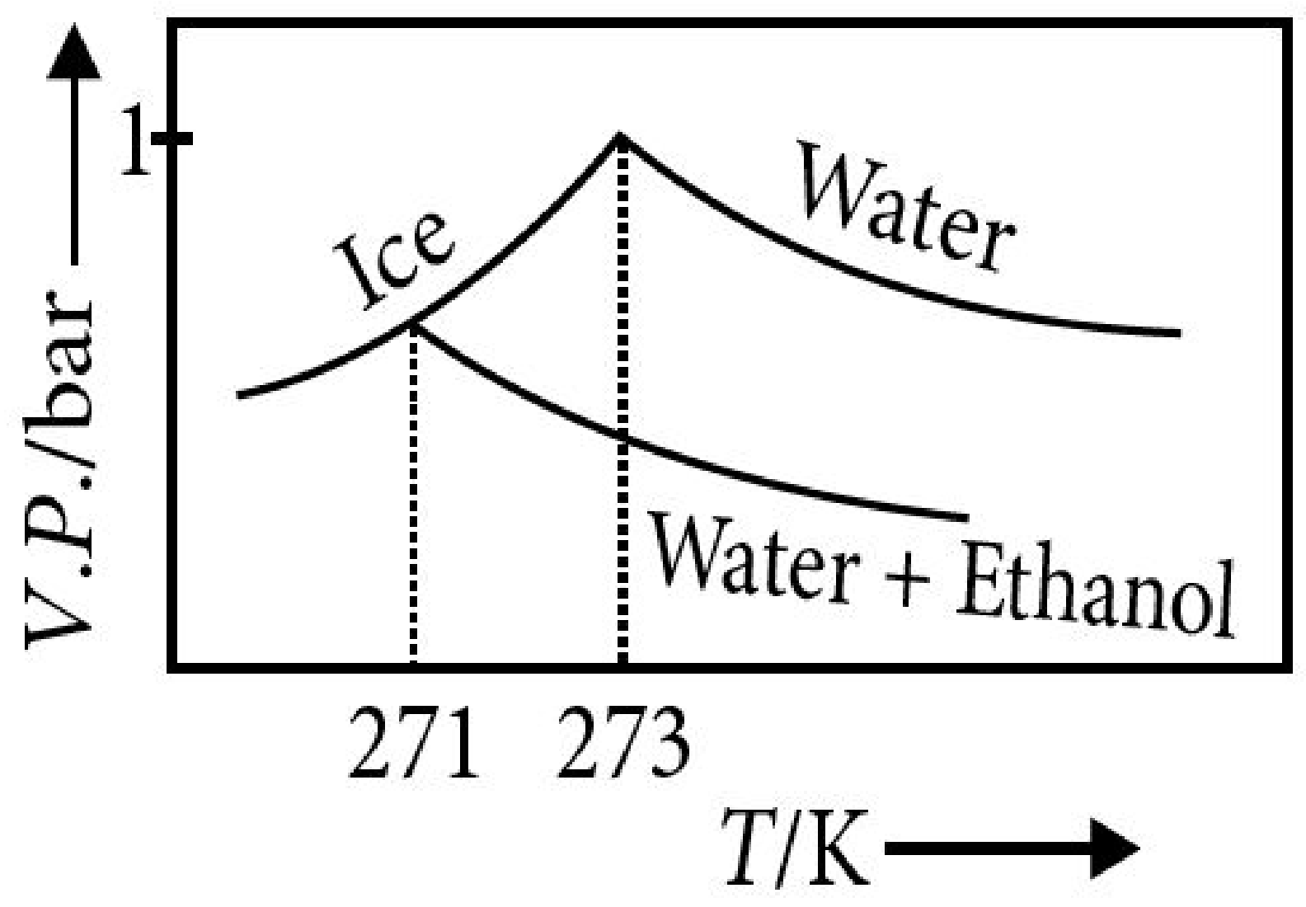
(a)


(b)


(c)



(d)



24. Correct set of four quantum numbers for the valence (outermost) electron of rubidium ($Z = 37$) is

(a) $5, 0, 0, +\frac{1}{2}$ (b) $5, 1, 0, +\frac{1}{2}$

(c) $5, 1, 1, +\frac{1}{2}$ (d) $6, 0, 0, +\frac{1}{2}$

25. Amount of oxalic acid present in a solution can be determined by its titration with $KMnO_4$ solution in the presence of H_2SO_4. The titration gives unsatisfactory result when carried out in the presence of HCl, because HCl

(a) oxidises oxalic acid to carbon dioxide and water

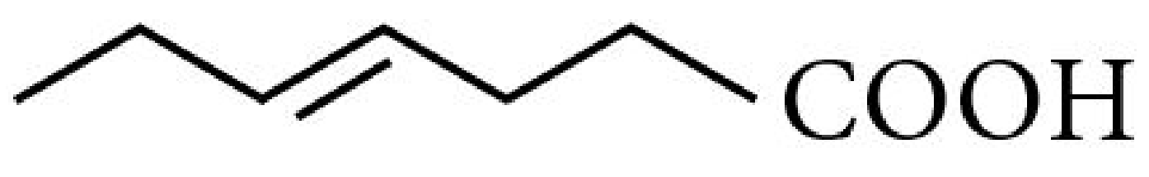
(b) gets oxidised by oxalic acid to chlorine

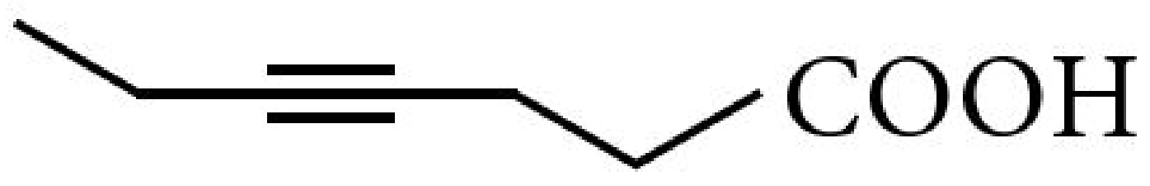
(c) furnishes H^+ ions in addition to those from oxalic acid

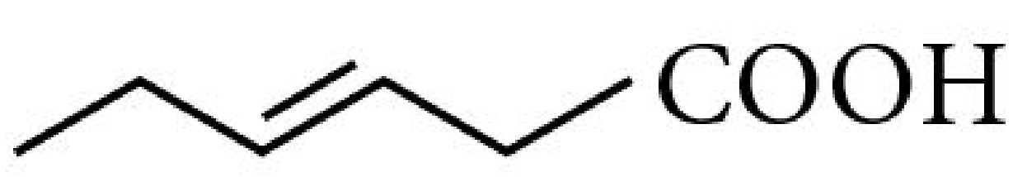
(d) reduces permanganate to Mn^{2+}.

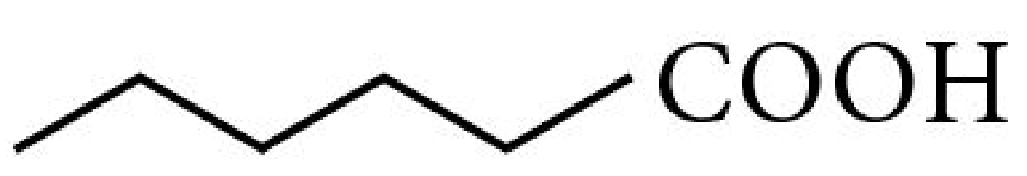
26. What is the product of following reaction?

$$\text{Hex-3-ynal} \xrightarrow[\text{(ii) PBr}_3\text{, (iii) Mg/ether, (iv) CO}_2/\text{H}_3\text{O}^+]{\text{(i) NaBH}_4} ?$$

(a) 

(b) 

(c) 

(d) 

27. Morphine, heroin and codeine are the examples of drug class

(a) tranquilizers

(b) narcotic analgesics

(c) non-narcotic analgesics

(d) anti-histamine.

28. Which of the following statements is not true?

(a) Nascent hydrogen can be produced even at room temperature but atomic hydrogen is produced at elevated temperature.

(b) Nascent hydrogen can never be isolated but atomic hydrogen can be isolated.

(c) Reducing power of atomic hydrogen is much less than that of nascent hydrogen.

(d) Both nascent and atomic hydrogen are more reactive than ordinary hydrogen.

29. In a compound AB the radius of A^+ ion is 95 pm and that of B^- is 181 pm. The type of crystal structure, radius ratio and coordination number of each of the ion are respectively.

(a) *fcc*, 0.524, 6 : 6 (b) *bcc*, 0.276, 6 : 6

(c) *fcc*, 0.524, 4 : 8 (d) *scc*, 0.91, 8 : 8

30. The most appropriate method of making egg-albumin sol is

(a) break an egg carefully and transfer the transparent part of the content to 100 mL of 5% w/V saline solution and stir well.

(b) keep the egg in boiling water for 10 minutes. After removing the shell, transfer the yellow part of the content to 100 mL of 5% w/V saline solution and homogenize with a mechanical shaker.

(c) keep the egg in boiling water for 10 minutes. After removing the shell, transfer the white part of the content to 100 mL of 5% w/V saline solution and homogenize with a mechanical shaker.

(d) break an egg carefully and transfer only the yellow part of the content to 100 mL of 5% w/V saline solution and stir well.

SOLUTIONS

1. **(a) :** $p = \frac{RT}{V - b}$

$p(V - b) = RT$

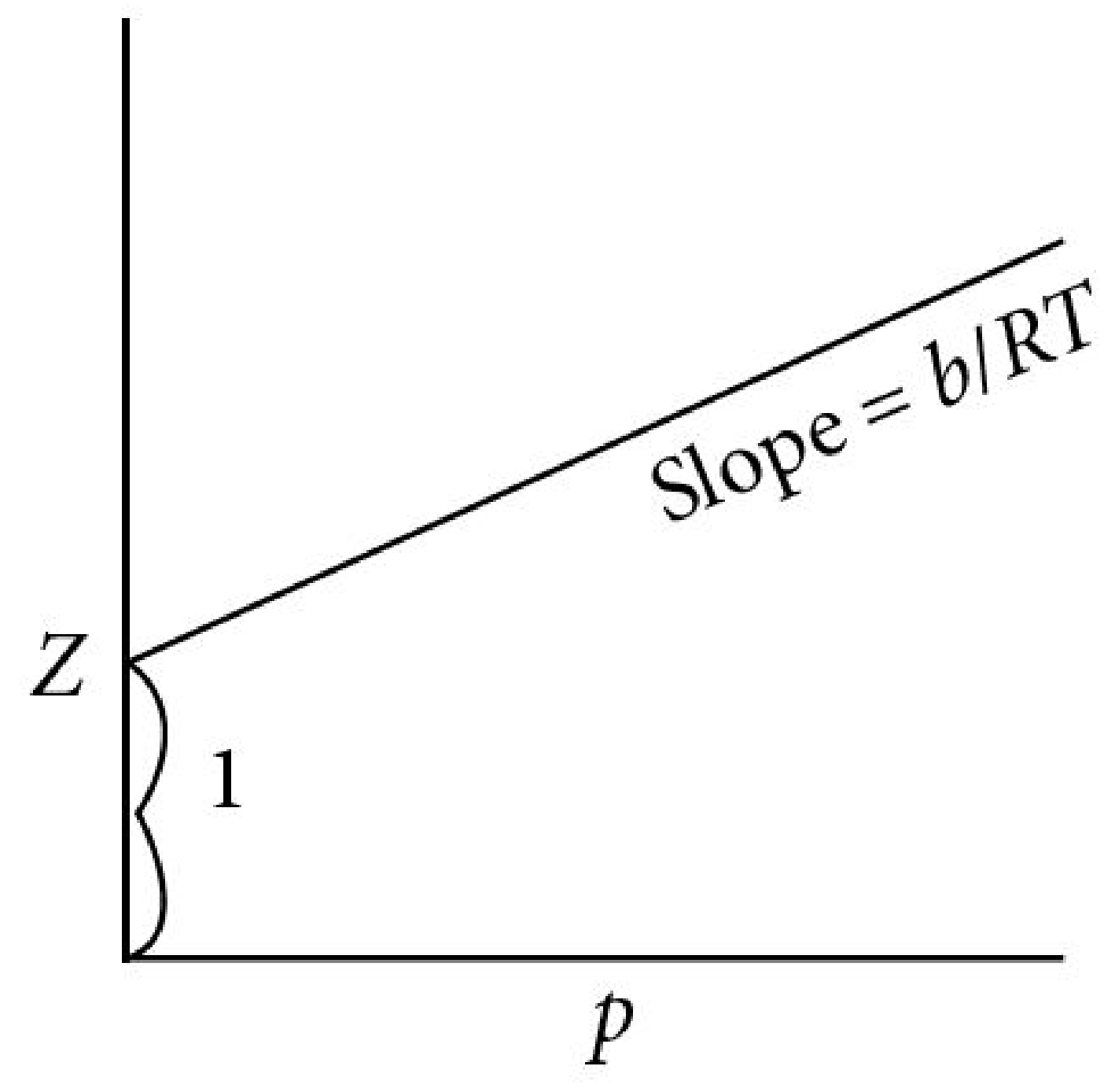
$pV - pb = RT$

$pV = RT + pb$

$\frac{pV}{RT} = \frac{pb}{RT} + 1$

$\frac{pV}{RT} = Z$

$Z = 1 + \frac{Pb}{RT}$



The slope of graph of Z versus p is given by $\frac{b}{RT}$. R and T are constants, the steepness of the curve of increase in Z Vs p depends solely on the value b. Xe has the largest radius and hence, maximum value of b. So, its graph will be steepest.

2. **(d) :** For the given electrochemical cell, the reactions are

At anode : $H_{2(g)} \rightarrow 2H^+_{(aq)} + 2e^-$

At cathode : $M^{4+}_{(aq)} + 2e^- \rightarrow M^{2+}_{(aq)}$

$$H_{2(g)} + M^{4+}_{(aq)} \rightarrow M^{2+}_{(aq)} + 2H^+_{(aq)}$$

$$E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{0.059}{2}\log\frac{[M^{2+}][H^+]^2}{[M^{4+}]}$$

$$0.092 = \left(E^\circ_{M^{4+}/M^{2+}} - E^\circ_{H^+/H_2}\right) - \frac{0.059}{2}\log\left(10^x\right)\left([H^+]\right)^2$$

$$0.092 = (0.151 - 0) - \frac{0.059}{2}\log\left(10^x \times 1^2\right)$$

$$0.092 = 0.151 - 0.0295\log 10^x$$

$$0.0295\log 10^x = 0.151 - 0.092$$

$$\log 10^x = \frac{0.059}{0.0295} = 2$$

$$10^x = 10^2 \quad \therefore \quad x = 2$$

3. **(a) :** $\Delta H_1 = mC\Delta t = 1000 \times 1 \times 75 = 75000$ cal $= 75$ kcal

4. **(b) :** More the branching, lesser will be the surface area and lesser will be the boiling point as van der Waals forces decrease. Hence, the correct order of their boiling point is III > II > I.

5. **(c) :** The addition product $B_2H_6 \cdot 2NH_3$ is considered an ionic product and on heating to 200°C, it forms a volatile compound called borazine.

6. **(c)**

7. **(d) :** Orbitals having same $(n + l)$ value in the absence of electric and magnetic field will have same energy.

8. **(a) :** In this conformation, the dihedral angle between methyl and chlorine atom is maximum and hence is most stable.

9. **(d) :**

$$\begin{array}{lccc} & NH_4HS_{(s)} & \rightleftharpoons & NH_{3(g)} + H_2S_{(g)} \\ \text{Initial pressure} & 0 & 0.5 & 0 \\ \text{At eqm.} & 0 & 0.5 + x & x \end{array}$$

Total pressure $= 0.5 + 2x = 0.84 \Rightarrow x = 0.17$ atm

$K_p = p_{NH_3} \times p_{H_2S} = (0.5 + 0.17)(0.17) = 0.11$ atm^2

10. **(c) :** According to Hardy—Schulze rule, the flocculation power is directly proportional to the charge. Thus, correct order is :

$$[Fe(CN)_6]^{4-} > PO_4^{3-} > SO_4^{2-} > Cl^-$$

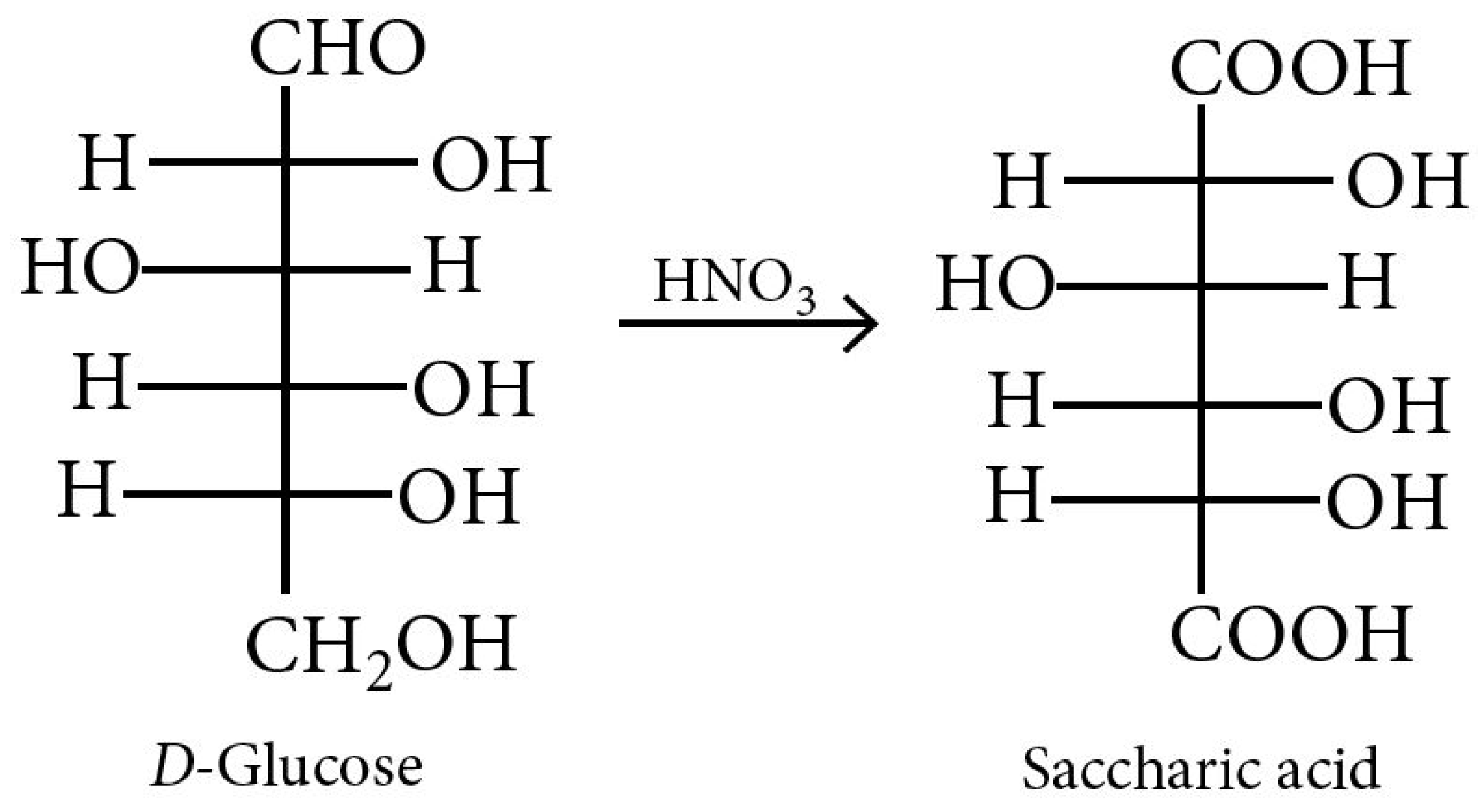
11. **(a) :** Ionic radius of Fe^{3+} is (0.64 Å) and Mn^{3+} is 0.66 Å. Other properties vary as indicated.

12. **(d) :** Oil slick in sea water decreases dissolved oxygen value.

13. **(a)** **14.** **(d)**

15. **(b) :**

$$\underset{(X)}{C_{12}H_{22}O_{11}} + H_2SO_4 \xrightarrow[\text{Solution}]{\text{Alcoholic}} \underset{\substack{D\text{-Glucose}\\(A)}}{C_6H_{12}O_6} + \underset{\substack{D\text{-Fructose}\\(B)}}{C_6H_{12}O_6}$$



$D(-)$ Fructose is a laevorotatory compound.

16. **(a) :** KCN first reduces $CuSO_4$ and then precipitates it as copper(I)cyanide, $Cu_2(CN)_2$ which reacts with excess of KCN to form $K_3[Cu(CN)_4]$. On the other hand, cadmium forms $K_2[Cd(CN)_4]$. These complexes dissociates as :

$$\begin{tikzcd} K_3[Cu(CN)_4] \arrow[r, shift left] & 3K^+ + [Cu(CN)_4]^{3-} \arrow[l, shift left] \arrow[d, shift left] \\ & Cu^+ + 4CN^- \arrow[u, shift left] \end{tikzcd}$$

$$\begin{tikzcd} K_2[Cd(CN)_4] \arrow[r, shift left] & 2K^+ + [Cd(CN)_4]^{2-} \arrow[l, shift left] \arrow[d, shift left] \\ & Cd^{2+} + 4CN^- \arrow[u, shift left] \end{tikzcd}$$

The second dissociation constant of copper complex is negligible and Cu is in +1 oxidation state and therefore, $[Cu(CN)_4]^{3-}$ is stable.

17. **(b) :** Under similar conditions of temperature and pressure

$$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}} \text{ and } \frac{t_2}{t_1} = \sqrt{\frac{M_2}{M_1}} \quad \left[\because t \propto \frac{1}{r}\right]$$

For He, $t_2 = 5 \times \sqrt{\frac{4}{2}} = 5 \times \sqrt{2} \neq 10$ sec.

For O_2, $t_2 = 5 \times \sqrt{\frac{32}{2}} = 5 \times 4 = 20$ sec.

For CO, $t_2 = 5 \times \sqrt{\frac{28}{2}} = 5 \times \sqrt{14} \neq 25$ sec.

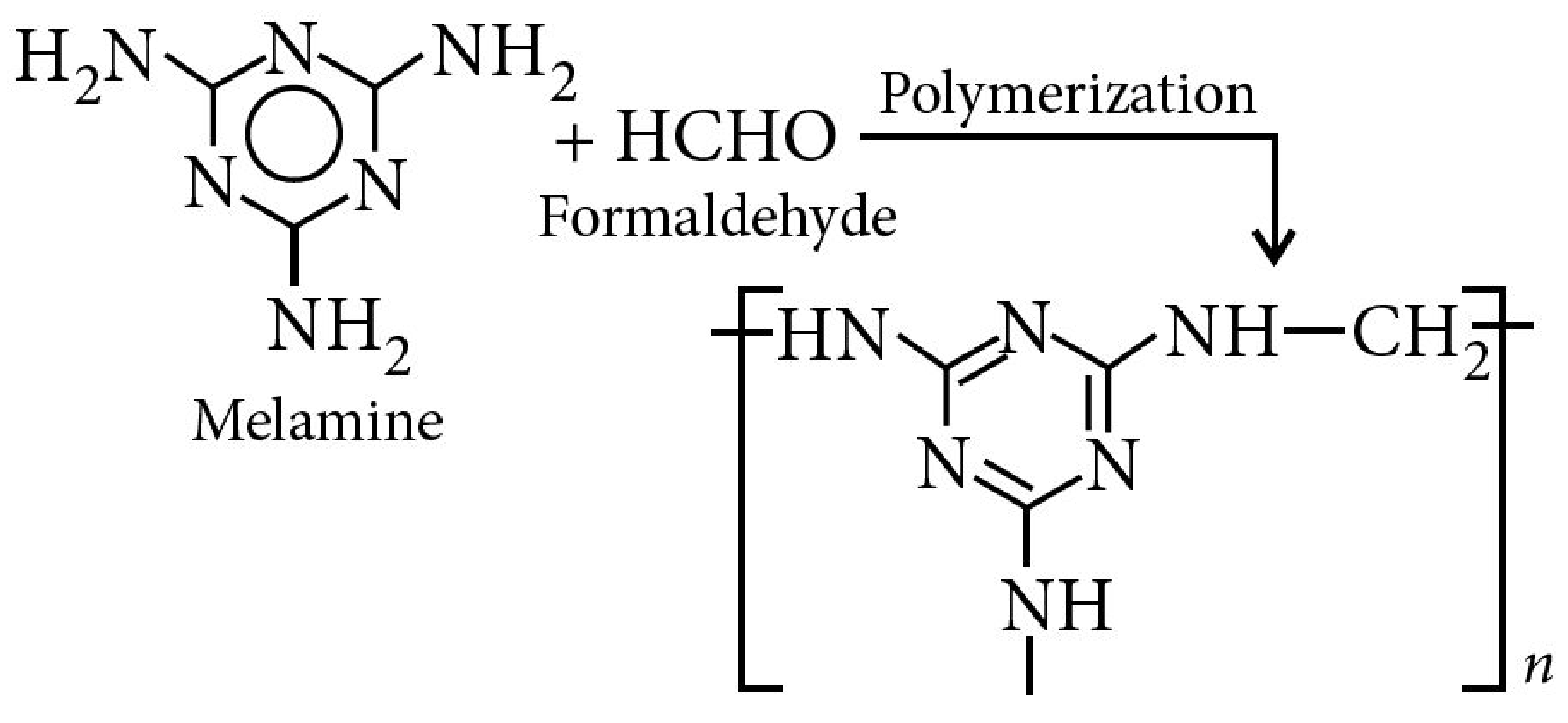
For CO_2, $t_2 = 5 \times \sqrt{\frac{44}{2}} = 5 \times \sqrt{22} \neq 55$ sec.

Quotable Quote

> “Before anything else, preparation is the key to success.”

Alexander Graham Bell

18. (d): The non-breakable plastic household crockery is made from copolymer of formaldehyde (HCHO) and melamine.



Melamine-formaldehyde polymer

19. (d): $2NH_3 + H_2O + CO_2 \longrightarrow \underset{(A)}{(NH_4)_2CO_3}$

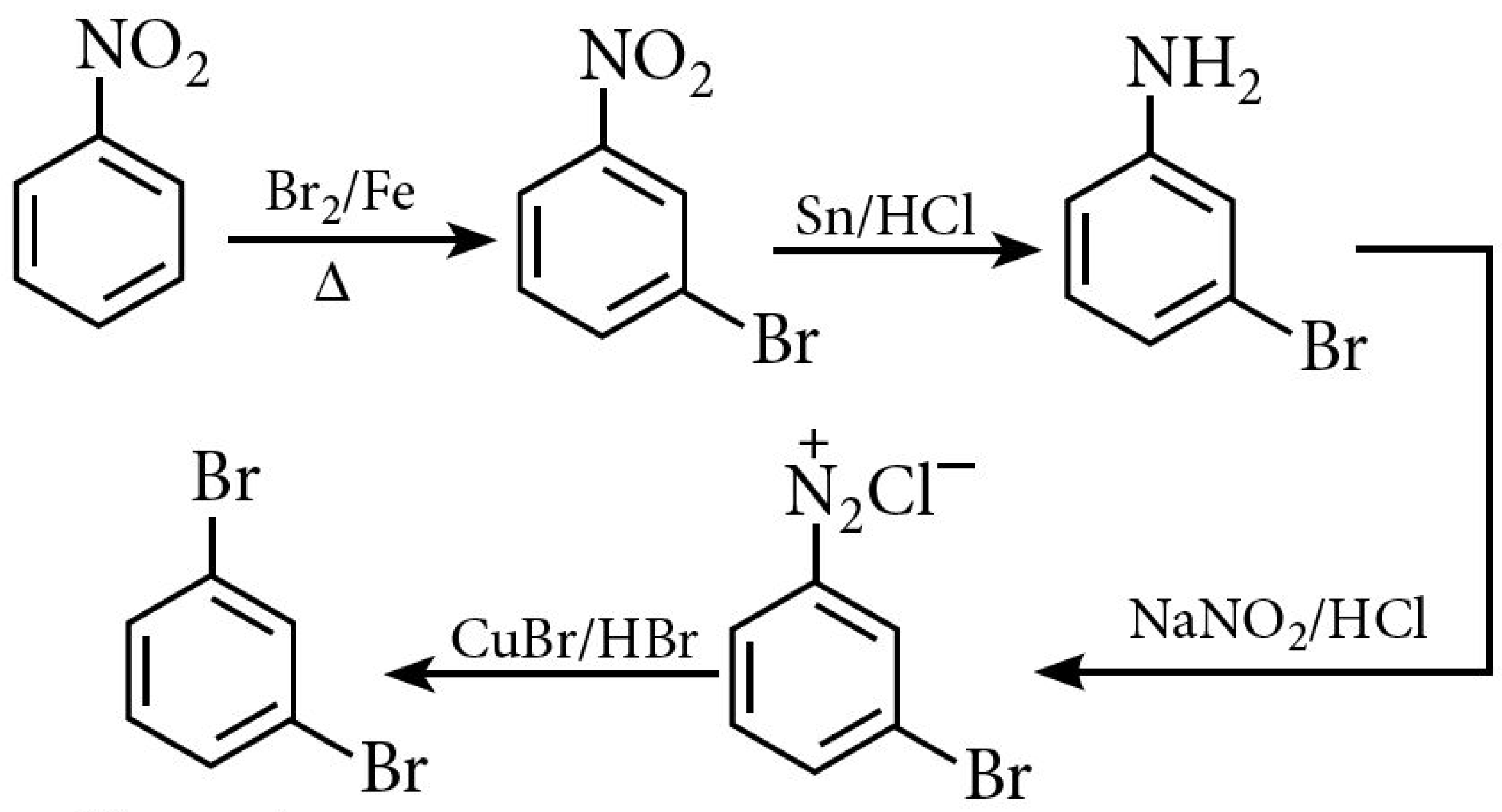
$(NH_4)_2CO_3 + H_2O + CO_2 \longrightarrow \underset{(B)}{2NH_4HCO_3}$

$NH_4HCO_3 + NaCl \longrightarrow NH_4Cl + \underset{(C)}{NaHCO_3}$

20. (d): Anti (staggered) conformation is most stable as two bulkier groups are opposite to each other and far apart.

21. (c): When hydrogen bonds are formed initially, heat is released (exothermic) and temperature rises. When more water is added, hydrogen bonds are broken and this requires energy (endothermic) and temperature drops.

22. (b):



m-dibromobenzene

23. (b): Depression in freezing point, $\Delta T_f = K_f \cdot m$

where, K_f = Freezing point depression constant,

m = Molality

$$m = \frac{\text{No. of moles of solute}}{\text{Mass of solvent (in kg)}} = \frac{\frac{34.5}{46}}{\frac{500}{1000}} = 1.5$$

$\therefore\ \Delta T_f = 2 \times 1.5 = 3\text{ K}\ ;\ \Delta T_f = T_f^\circ - T_f$

$3 = 273 - T_f$ (Freezing point of H_2O = 273 K)

$T_f = 273 - 3 = 270\text{ K}$

Thus, freezing point of solution = 270 K

Also, as temperature increases, the vapour pressure increases. Hence, the curve is as given in option (b).

24. (a): The electronic configuration of Rb is [Kr] $5s^1$

Thus, its valence electron enters in 5*s*-orbital.

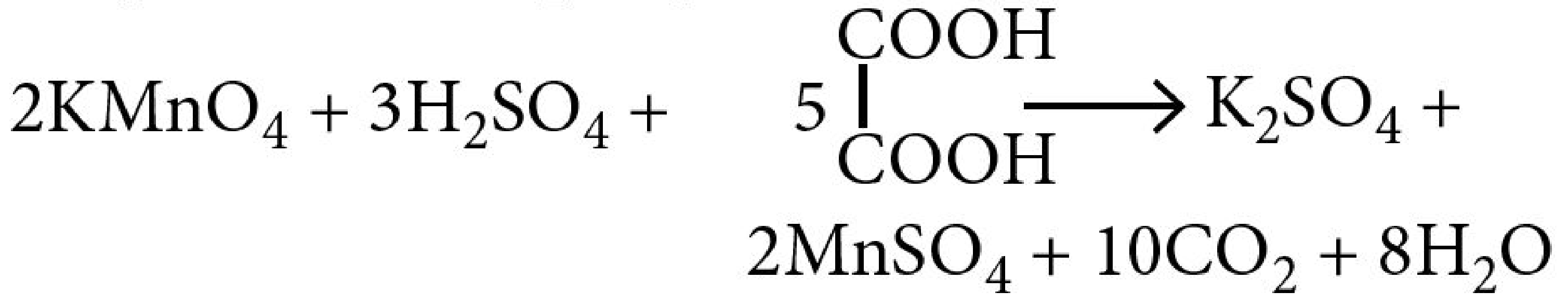
For 5*s* orbital, $n = 5$

$l = 0$ (as orbital is *s*)

$m = -l$ to $+l$ including zero, $m = 0\ ;\ s = +\frac{1}{2}$

Thus, the correct set of quantum numbers for the valence electron of rubidium is $5, 0, 0, +\frac{1}{2}$

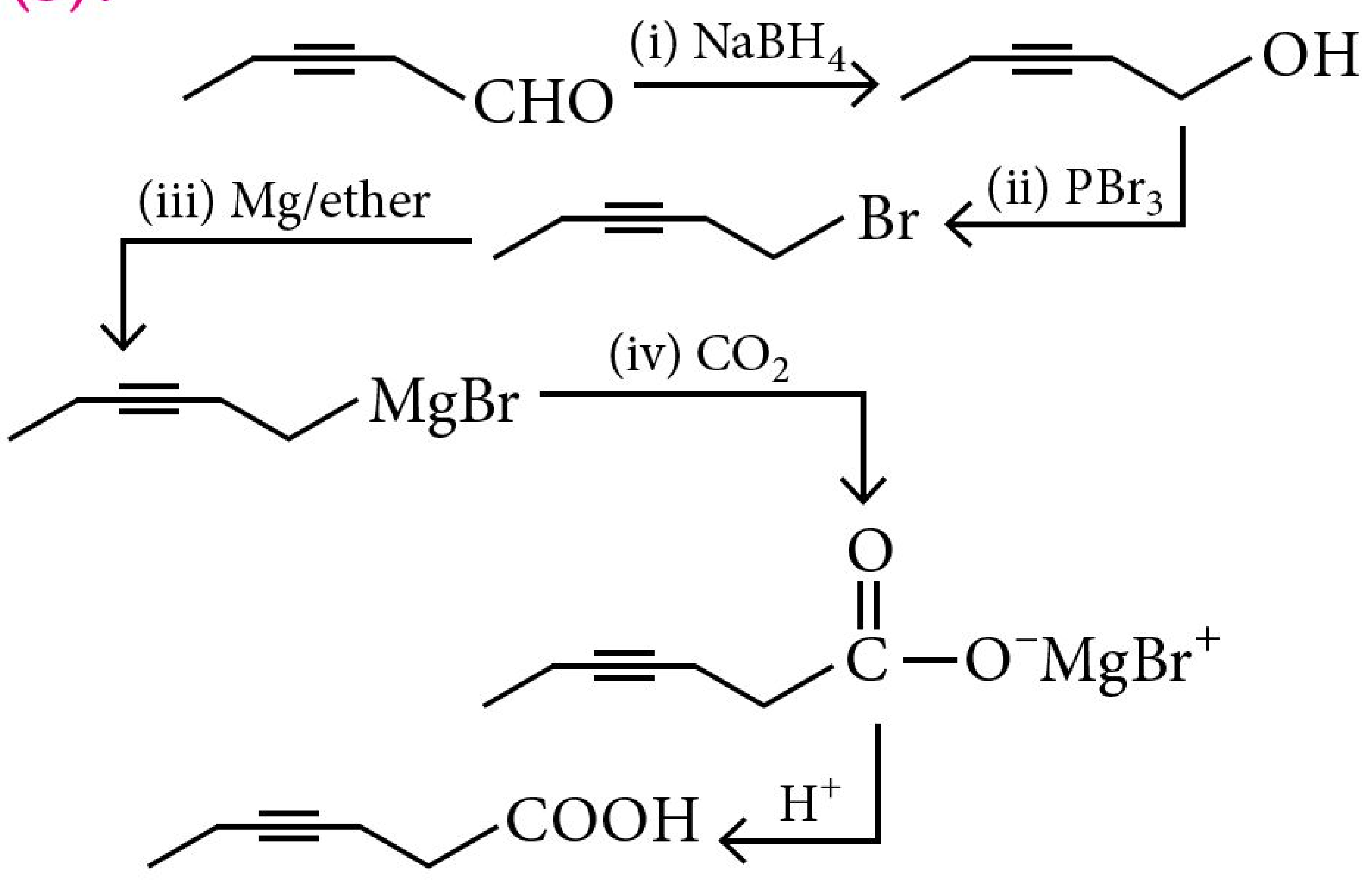
25. (d): Oxalic acid present in a solution can be determined by its titration with $KMnO_4$ solution in the presence of H_2SO_4.



$$2KMnO_4 + 3H_2SO_4 + 5\begin{array}{c}COOH\\|\\COOH\end{array} \longrightarrow K_2SO_4 + 2MnSO_4 + 10CO_2 + 8H_2O$$

Titration cannot be done in the presence of HCl because $KMnO_4$ being a strong oxidizing agent oxidises HCl to Cl_2 and get itself reduced to Mn^{2+}. So actual amount of oxalic acid in solution cannot be determined.

26. (b):



27. (b): Morphine and many of its homologues compounds relieve pain and produce sleep. They come under narcotic analgesics.

28. (c): Reducing power of atomic hydrogen is much greater than that of nascent hydrogen.

29. (a): Radius ratio of $AB = \frac{A^+}{B^-} = \frac{95}{181} = 0.524$

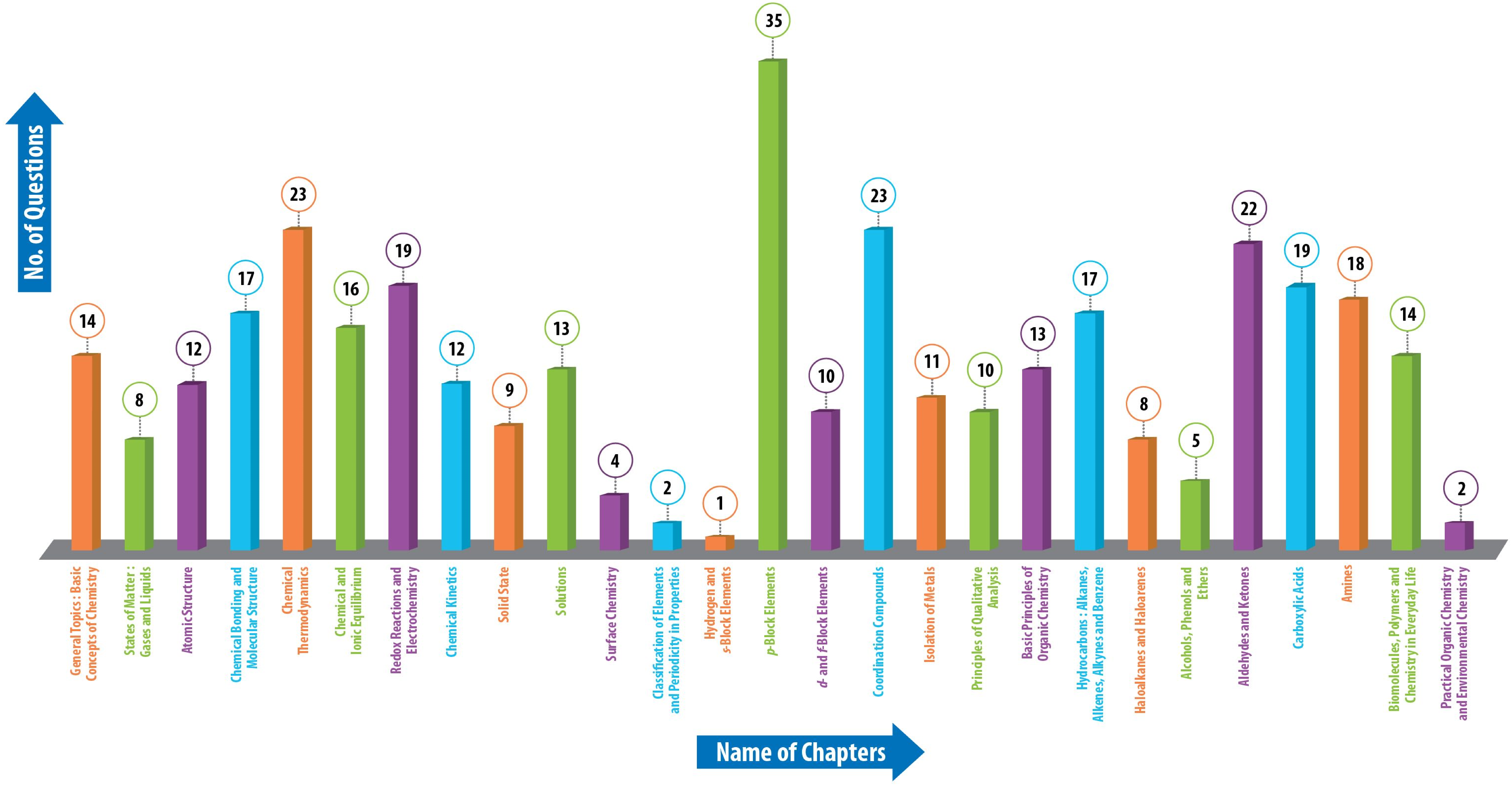
Hence, it has *fcc* structure and C.N. is 6 : 6.

30. (a): Egg albumin is the transparent liquid contained in the egg.

◆◆

ARE YOU READY FOR JEE ADVANCED 2025

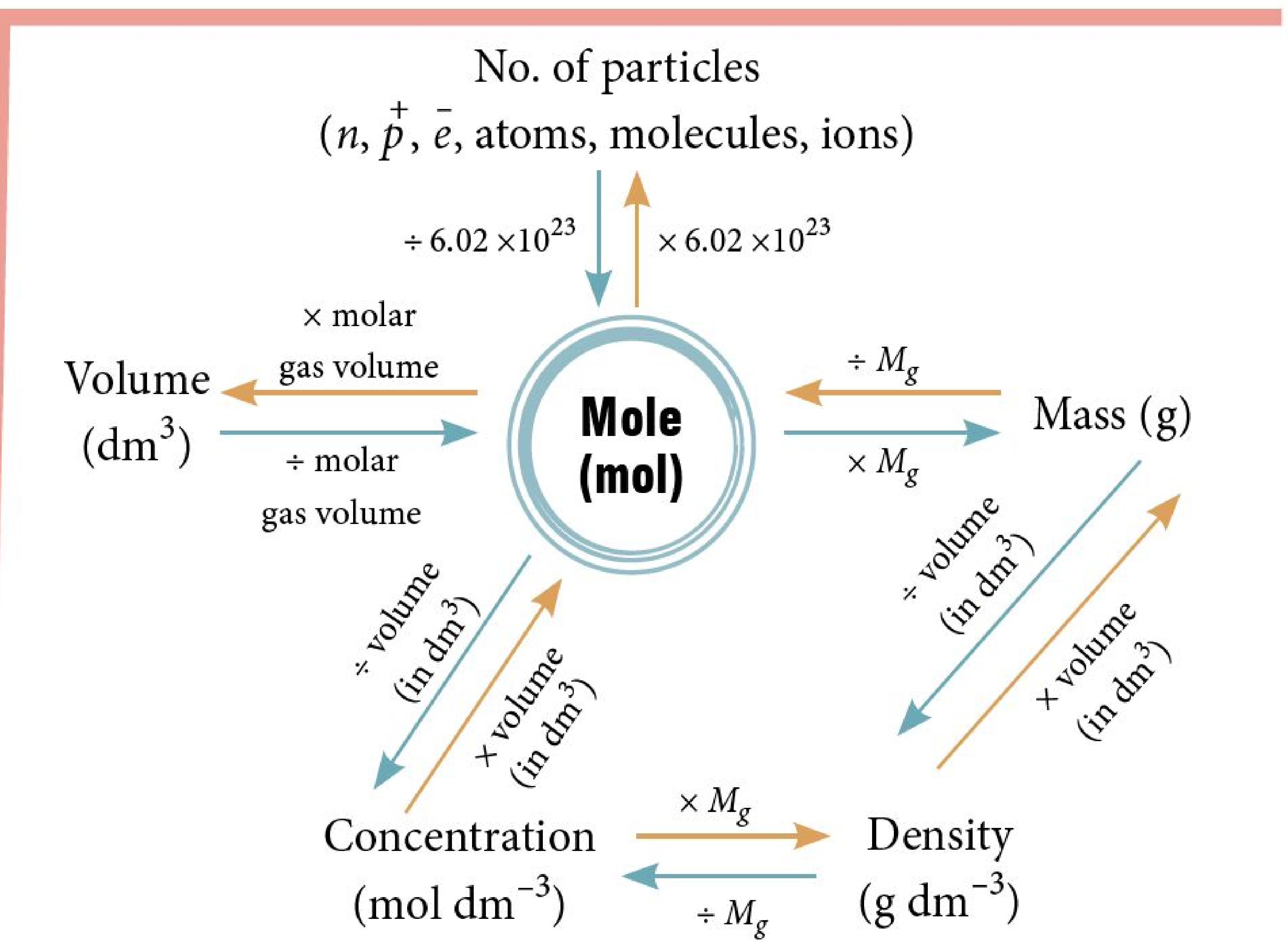
Past 10 Years (2015-2024) Chapterwise Trend Analysis of JEE Advanced Questions



PHYSICAL CHEMISTRY

Some Basic Concepts of Chemistry

MOLE CALCULATIONS


No. of particles
(n, $\overset{+}{p}$, $\bar{e}$, atoms, molecules, ions)
÷ 6.02×10^{23}
× 6.02×10^{23}
× molar gas volume
Volume (dm^3)
÷ molar gas volume
Mole (mol)
÷ M_g
× M_g
Mass (g)
÷ volume (in dm^3)
× volume (in dm^3)
÷ volume (in dm^3)
× volume (in dm^3)
Concentration (mol dm^{-3})
× M_g
÷ M_g
Density (g dm^{-3})

States of Matter

INTERMOLECULAR FORCES

London or Dispersion Forces

The weakest intermolecular forces present among non polar molecules and atoms.

Dipole-dipole forces

Forces act between the molecules possessing permanent dipole.

Dipole-induced dipole forces

The attractive forces operates between polar molecule having permanent dipole and the molecule lacking permanant dipole.

Physical Properties of Gases

- Gases are highly compressible.
- Gases have much lower density then liquids.
- They mix evenly and completely in all proportions.
- Gases exert pressure equally in all directions.
- Volume and shapes of gases are not fixed.

GASES

The Gas Laws

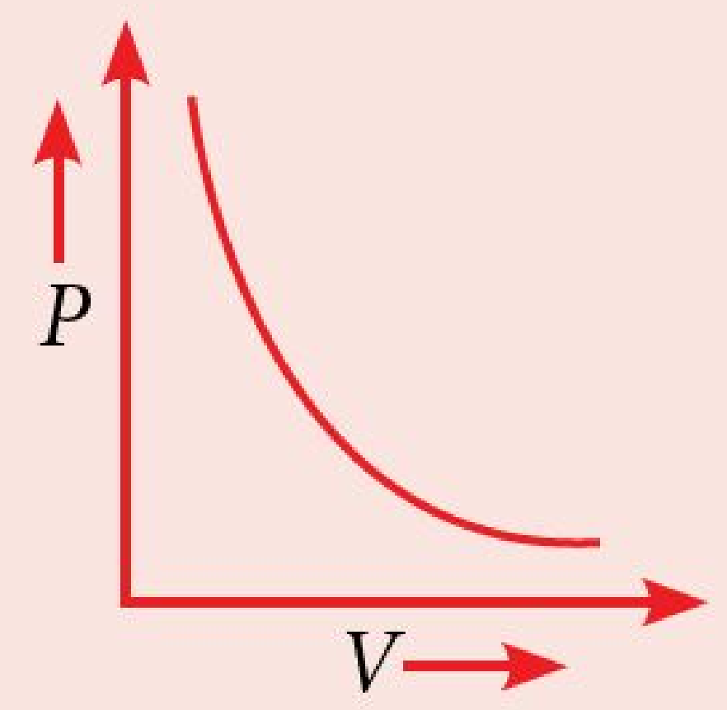
Boyle's Law (Pressure-Volume Relationship)

At constant temperature,

$$\text{Volume} \propto \frac{1}{\text{Pressure}}$$

$$\Rightarrow \text{Volume} \times \text{pressure} = \text{Constant}$$

i.e., $P_1V_1 = P_2V_2$ or $\frac{P_1}{P_2} = \frac{V_2}{V_1}$

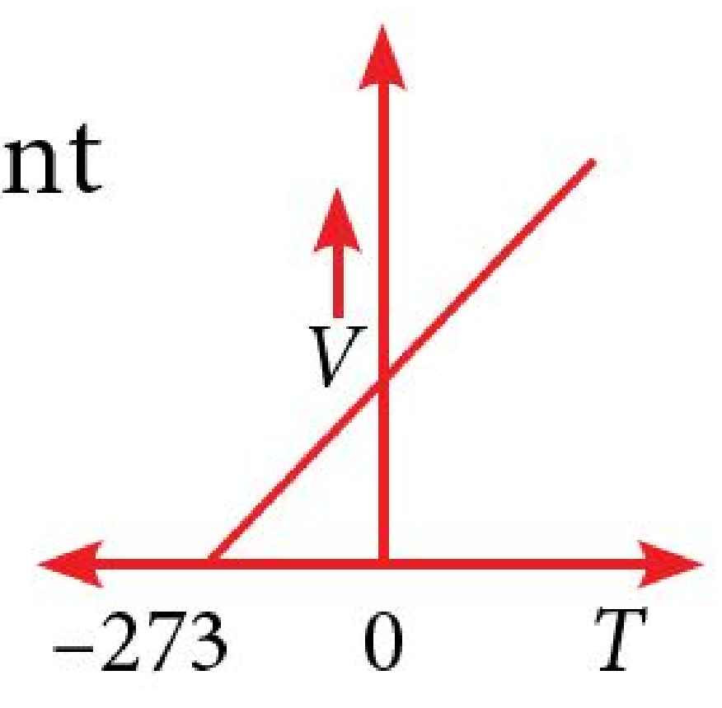


Charle's Law (Temperature - Volume Relationship)

At constant Pressure,

$$\text{Volume} \propto \text{temperature} \Rightarrow \frac{V}{T} = \text{constant}$$

i.e., $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

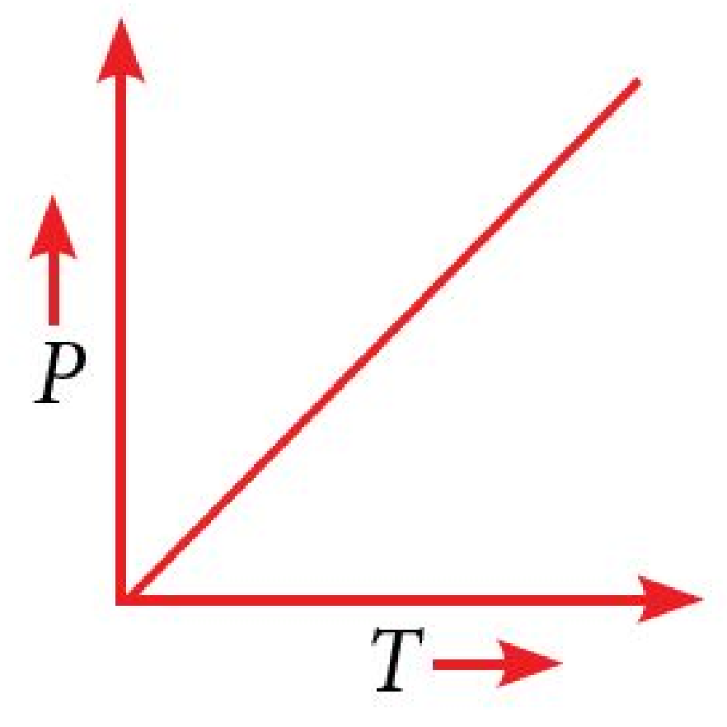


Gay Lussac's Law (Pressure- Temperature Relationship)

At constant volume,
Pressure ∝ temperature

$$\rightarrow \frac{P}{T} = \text{Constant}$$

i.e., $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ or $P_1T_2 = P_2T_1$

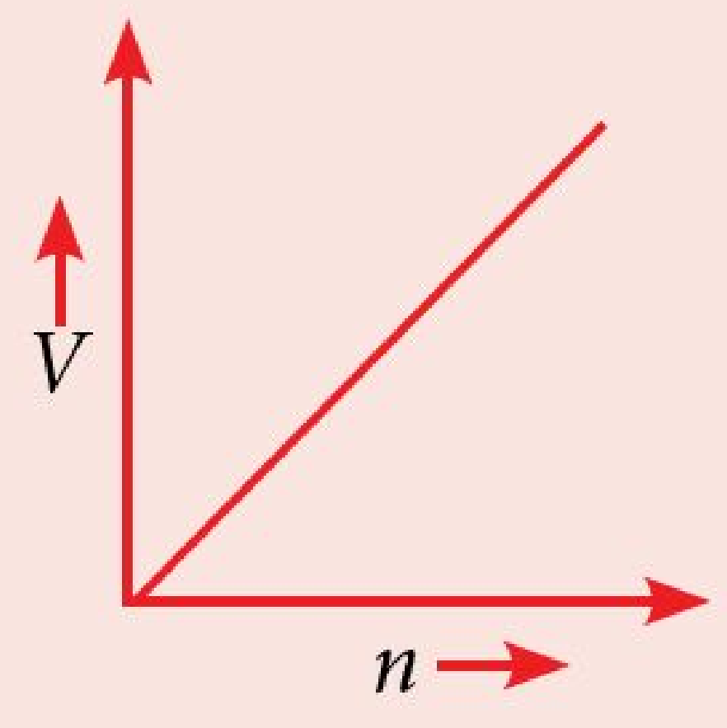


Avagadro Law (Volume-Amount Relationship)

At constant Pressure and temperature,
Volume ∝ No. of moles

$$\Rightarrow \frac{V}{n} = \text{Constant}$$

i.e., $\frac{V_1}{n_1} = \frac{V_2}{n_2}$ or $V_1n_2 = V_2n_1$



Ideal Gas Equation

Combining Boyle's, Charles' and Avogadro laws

$$V \propto \frac{1}{P} \times t \times n \Rightarrow PV \propto nT \Rightarrow \boxed{PV = nRT}$$

Here 'R' is gas constant.

$R = 8.314\ \text{JK}^{-1}\ \text{mol}^{-1}$

$R = 0.08\ \text{L atm K}^{-1}\ \text{mol}^{-1}$

$R = 2 \times 10^{-3}\ \text{k cal K}^{-1}\text{mol}^{-1}$

Kinetic Molecular Theory of Gases

- Gases contains a large number of small identical particles called molecules.
- Size and mass of all the molecules of gases are identical.
- Particles of a gas are always in constant and random motion.
- Particles of a gas move in all possible directions in straight line.
- Collisions of gas molecules are perfectly elastic.

Dalton's Law of Partial Pressure

The total pressure exerted by the mixture of non-reactive gases is equals to the sum of partial pressures of individual gases.

$P_{\text{Total}} = P_1 + P_2 + P_3$ (At constant T, V)

Deviation from Ideal Gas Equation (Real Gases)

- Real gases show deviations from ideal gas law because gaseous molecules interact with each other. Due to this the pressure exerted by the real gas is lower than that of the pressure exerted by the ideal gas.

$$\boxed{P_{\text{ideal}} = P_{\text{real}} + \frac{an^2}{V^2}},\ \boxed{\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT}$$

- Compressibility factor $(z) = \dfrac{PV}{nRT}$,

$$Z = \frac{V_m.real}{22.4\ \text{L}}$$

- Pressure correction factor $\Delta P = \dfrac{an^2}{V^2}$
- Volume correction factor

$$\Delta V = nb \Rightarrow b = N_A \times 4 \times \frac{4}{3}\pi R^3$$

Molecular Velocities

$$\text{RMS velocity} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3PV}{M}} = \sqrt{\frac{3P}{d}}$$

$$\text{Average velocity} = \sqrt{\frac{8RT}{\pi M}} = \sqrt{\frac{8P}{\pi d}}$$

$$\text{Most Probable velocity} = \sqrt{\frac{2RT}{M}} = \sqrt{\frac{2P}{d}}$$

Liquification of Gases

- Gases should be cooled below their critical temperature (T_c) for their liquification.
- Volume of one mole of gas at critical temperature is called critical volume (V_c) and pressure at this temperature is called critical pressure (P_c)

Kinetic Gas Equation

$$PV = \frac{1}{3}mnc^2 \quad \text{or} \quad PV = \frac{2}{3}K.E.$$

LIQUID

Viscosity

- Viscosity is a measure of resistance to flow.
- Viscosity coefficient (η) is the force when velocity gradient is unity and the area of contact is unit area.

  The SI unit of (η) is Newton second per square metre (Ns m^{-2})

Surface Tension

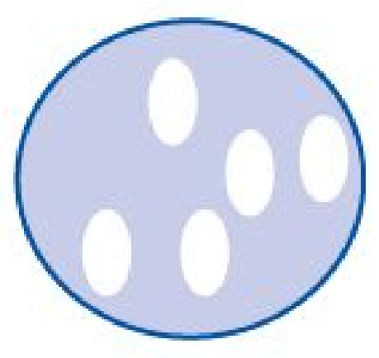
The force acting per unit length is perpendicular to the line drawn in the surface of liquid denoted by gamma (γ) with S.I. unit Nm^{-1}.

Vapour Pressure

It is the pressure exerted by the vapours of the liquid in equilibrium with its liquid at a given temperature.

Atomic Structure

Thomson's Plum Pudding Model



Discharge tube experiment →

Cathode Ray	Anode Ray
Cathode → anode	Anode → Cathode
J. J. Thomson	Goldstein
–ve charge	+ve charge
Both travel in straight line, have mass, KE, produce heating effect, cast shadow, deflected in electric as well as in magnetic field.	
Produce *X*-ray	*NA*
e/m is same for all gases	e/m is different for all gases
Electron	Proton

Rutherford Nuclear Model

Rutherford's α-particle scattering Experiment-Gold Foil

- Most of the α-particles are undeflected.
- Few of them deviated as they pass by nucleus.
- Very few are bounced back as they hit the nucleus

Drawback-can not explain the stability of atom as well as electronic structure of atom.

Bohr Atomic Model

- Orbits- concentric path
- No e^- present in between the orbits
- E of orbit increases as we go away from nucleus and $E_\infty = 0$
- Only those orbits are allowed whose Angular momentum $(mvr) = n\left(\dfrac{h}{2\pi}\right)$
- λ of e^- related to circumference of orbit $2\pi r = n\lambda$

Radius of bohr orbit

$$r = 0.529 \times \frac{n^2}{Z}\ \text{Å}$$

Energy of Bohr orbit

$$E_n = -\,2.18 \times 10^{-18} \times \frac{Z^2}{n^2}\ \text{J/atom}$$

$$E_n = -\,1.313 \times 10^{6} \times \frac{Z^2}{n^2}\ \text{J/mol}$$

Ionization Energy

$$IE = E_\infty - E_n$$

$$\frac{IE_1}{IE_2} = \frac{Z_1^2}{Z_2^2} \times \frac{n_2^2}{n_1^2}$$

Energy of electron

$$KE = \frac{Ze^2}{2r}$$

$$PE = \frac{-Ze^2}{r}$$

Emission spectra

Lyman	$n_1 = 1$	$n_2 > 1$	UV
Balmer	2	>2	Visible
Paschen	3	>3	IR
Brackett	4	>4	IR
Pfund	5	>5	IR

$$\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]Z^2$$

$$R = 109678\ \text{cm}^{-1}$$

No. of spectral line

$$= \frac{\left[(n_2 - n_1)(n_2 - n_1 + 1)\right]}{2}$$

Velocity of electron in n^{th} orbit

$$V = 2.18 \times 10^{8} \times \frac{z}{n}\ \text{cm/sec}$$

Dual Nature of Light

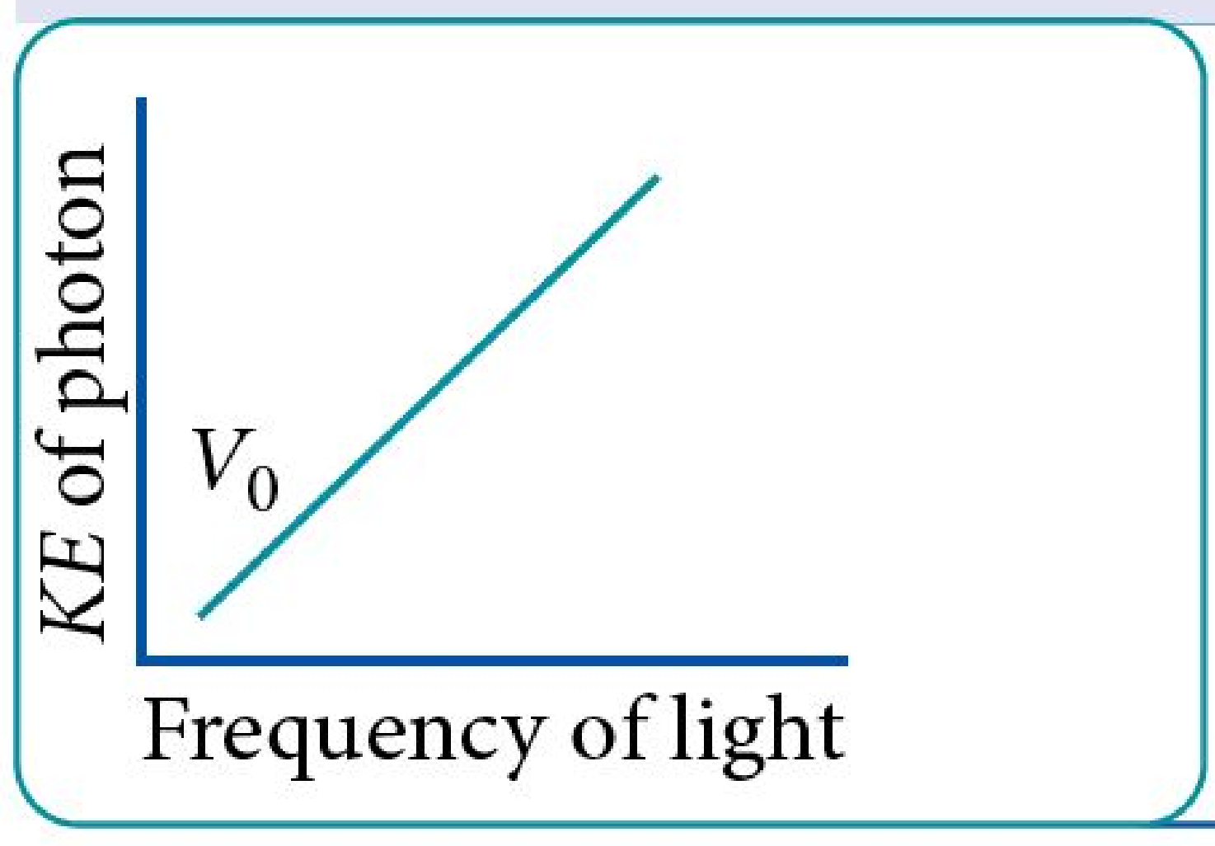
$$E = h\nu = \frac{hc}{\lambda};\ h = 6.62 \times 10^{-34}\ \text{J sec}$$

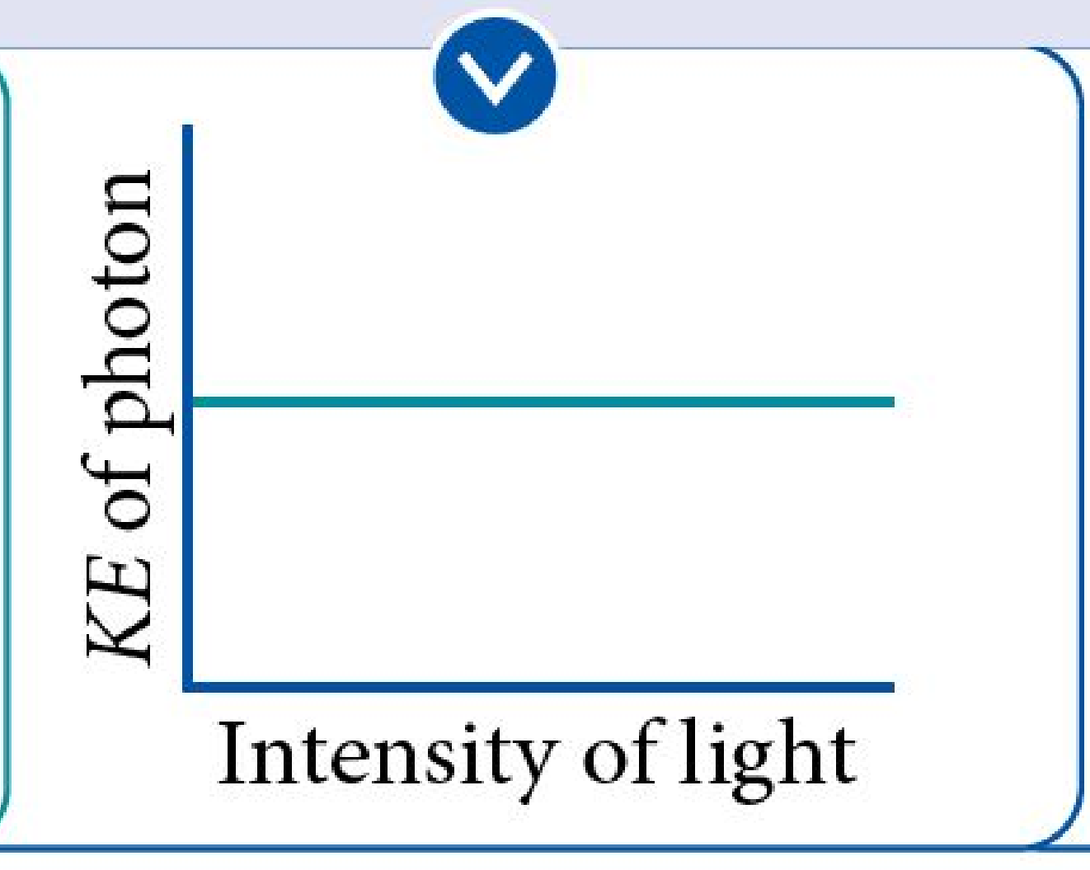
$$c = 3 \times 10^{8}\ \text{m/s}$$

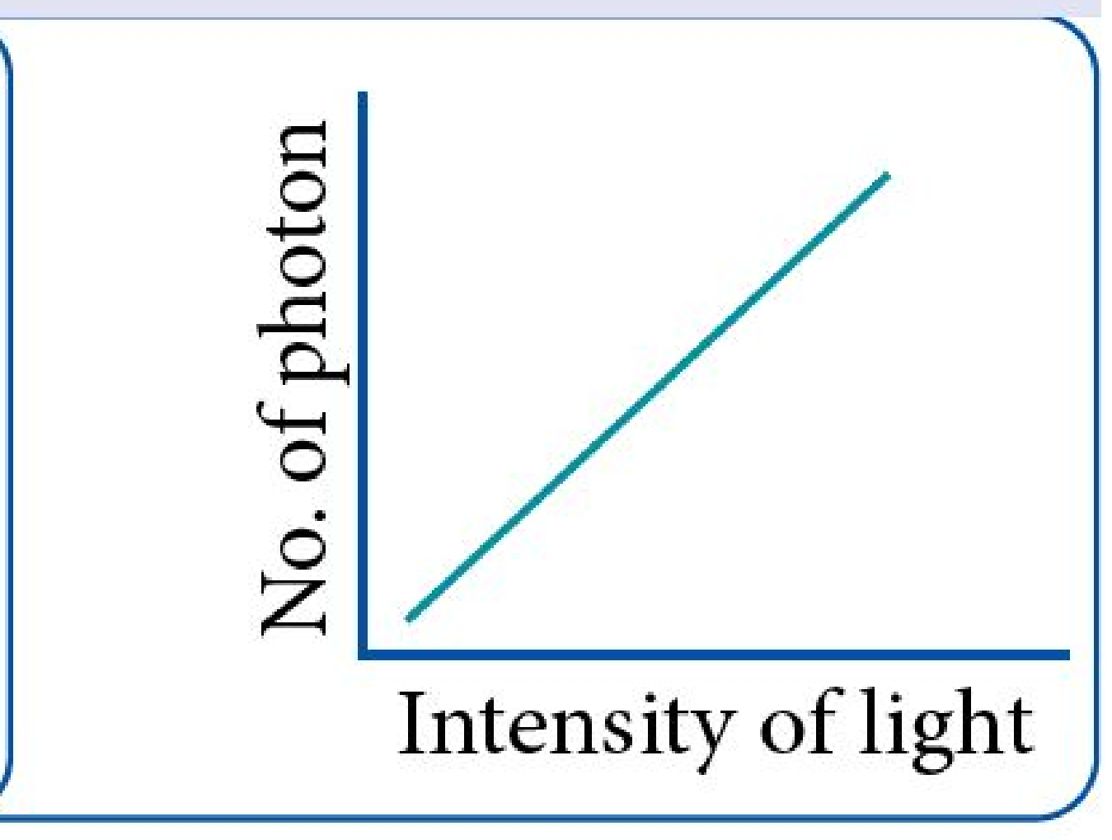
Photoelectric effect

$$h\nu = h\nu_0 + \frac{1}{2}mv^2$$

- $h\nu_0$ = threshold energy
- Intensity ∝ no. of photon
- No. of photo e^- ↑ on ↑ intensity.
- *KE* of photo e^- remain constant on ↑ intensity
- *KE* ↑ on ↑ frequency ($\nu \propto E$)







Quantum Mechanical Model

No. of radial nodes $= n - l - 1$

No. of angular nodes $= l$

No. of total nodes $= n - 1$

Aufbau : Building up-e are filled in orbitals in the increasing order of their energies

$(n + l)$ rule: higher the $(n + l)$, higher the energy

Hund's rule of maximum multiplicity : Degenerate orbitals are first filled singly than only get paired up.

Pauli exclusion Principle : No two e^- of the same atom can have same set of all 4 quantum numbers.

Dual Nature of Electron

De broglie mater wave length, $\lambda = \dfrac{h}{mV}$

Heisenberg uncertainty principle: $\Delta x.\Delta p \geq \dfrac{h}{4\pi}$; $\Delta x.\Delta V \geq \dfrac{h}{4\pi m}$

Principle QN (n)	**Azimuthal QN (l)**	**Magnetic QN (m)**	**Spin QN (s)**
Orbit	subshell	orbital	spin
Distance from nucleus	shape	orientation	
$n = 1, 2, 3$	$l = 0$ to $(n - 1)$	$m = -l, 0, +l$	$s = +\dfrac{1}{2}, -\dfrac{1}{2}$
Independent	Depends on n	Depends on n and l	Independent
No. of $e = 2n^2$	$2(2l + 1)$		
$p = \dfrac{nh}{2\neq}$	$P_l = \dfrac{h}{2\pi}\sqrt{l(l+1)}$		$P_s = \dfrac{h}{2\pi}\sqrt{s(s+1)}$

Chemical Bonding and Molecular Structure

- Pauling's equation,
  % Ionic character $= 16(\chi_A - \chi_B) + 3.5(\chi_A - \chi_B)^2$
- Hannay and Smith equation,
  % Ionic character $= \left[1 - e^{-\frac{1}{4}(\chi_A - \chi_B)}\right] \times 100$
  where, χ_A and χ_B are electronegativities of A and B atoms respectively.

% Ionic character

$$= \frac{\text{Actual dipole moment of the bond}}{\text{Dipole moment of pure ionic bond}} \times 100$$

Fajan's rule :
Polarising power ∝ 1/ size of cation
Polarisability of anion ∝ size of anion
Covalent character ∝ size of anion
$\propto \dfrac{1}{\text{size of cation}}$ ∝ charge on anion and cation.

Formal charge on an atom in molecule/ion :

$$\left[\begin{array}{c}\text{Total number of valence}\\ \text{electrons in the free atom}\end{array}\right] - \left[\begin{array}{c}\text{Total number of non-bonding}\\ \text{electrons or lone pair}\end{array}\right] - \frac{1}{2}\left[\begin{array}{c}\text{Total number of bonding}\\ \text{or shared pair of electrons}\end{array}\right]$$

Bond energy $\propto \dfrac{1}{\text{bond length}} \propto$ % s-character $\propto \dfrac{1}{\text{no. of lone pairs}}$

Bond angle ∝ % s-character ∝ electronegativity of central atom $\propto \dfrac{1}{\text{electronegativity of surrounding atom}}$

Bond length ∝ size of atom $\propto \dfrac{1}{\%\ s\text{-character}} \propto \dfrac{1}{\text{bond multiplicity}}$

Dipole moment = electric charge × bond length or $\mu = q \times d$
Unit of μ is Debye (D),
$1\text{ D} = 10^{-18}$ esu cm $= 3.33 \times 10^{-30}$ C m

Dipole moment of the molecule

$$= \sqrt{\mu_1^2 + \mu_2^2 + 2\mu_1\mu_2\cos\theta}$$

where, μ_1 and μ_2 are the bond moments of various bonds present in the molecule, θ is the bond angle between two bonds in a given molecule.

$$\text{Electronic charge } (e^-) = \frac{\text{Dipole moment}}{\text{Bond length}}$$

To predict hybridisation of central atom and shape of molecule/ion :

$$X = \frac{1}{2}\left[\begin{Bmatrix}\text{No. of valence electrons}\\ \text{of the central atom}\end{Bmatrix} + \begin{Bmatrix}\text{No. of monovalent atoms/groups}\\ \text{surrounding the central atom}\end{Bmatrix} - \begin{Bmatrix}\text{Charge on the cation if the given}\\ \text{species is a polyatomic cation}\end{Bmatrix} + \begin{Bmatrix}\text{Charge on the anion if the given}\\ \text{species is a polyatomic anion}\end{Bmatrix}\right]$$

The order of energies of molecular orbitals for homonuclear diatomic lighter elements like B_2, C_2 and N_2 is $\sigma 1s$, σ^*1s, $\sigma 2s$, σ^*2s, $\pi 2p_x = \pi 2p_y$, $\sigma 2p_z$, $\pi^*2p_x = \pi^*2p_y$, σ^*2p_z

$$\text{Bond order} = \frac{N_b - N_a}{2}$$

where N_b = Numbr of electrons in bonding molecular orbitals, N_a = Number of electrons in antibonding molecular orbitals

If $N_b > N_a$, molecule is stable.

If $N_b < N_a$, molecule is unstable.

If $N_b = N_a$, molecule is unstable.

If bond order is greater than zero, the molecule or ion exists otherwise not.

For diatomic molecules like O_2, F_2 and Ne : $\sigma 1s$, σ^*1s, $\sigma 2s$, σ^*2s, $\sigma 2p_z$, $\pi 2p_x = \pi 2p_y$, $\pi^*2p_x = \pi^*2p_y$, σ^*2p_z

$$\text{Bond order} \propto \text{Bond energy} \propto \text{Stability} \propto \frac{1}{\text{Bond length}}$$

Chemical Thermodynamics

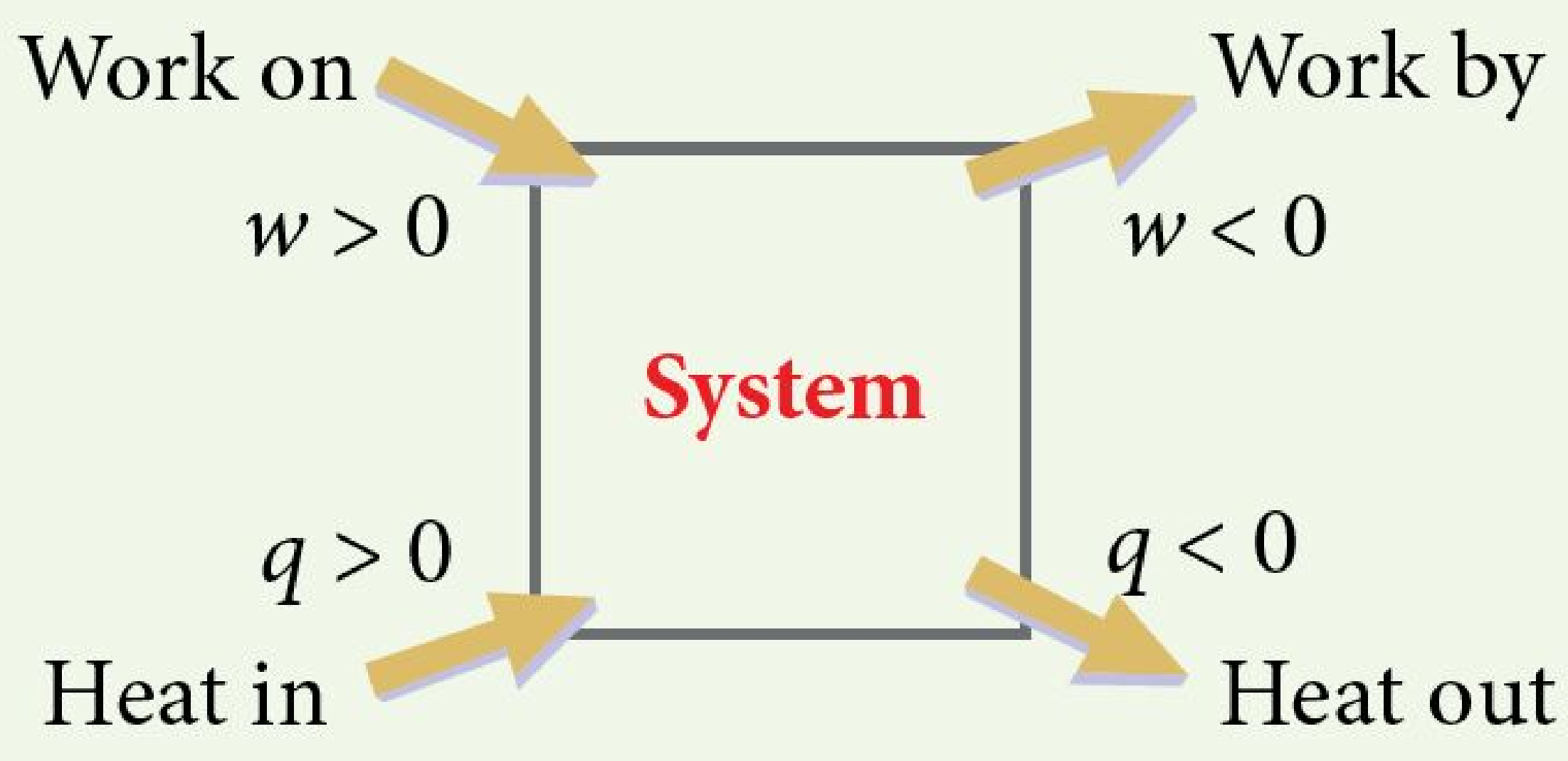
Isothermal and Adiabatic Processes

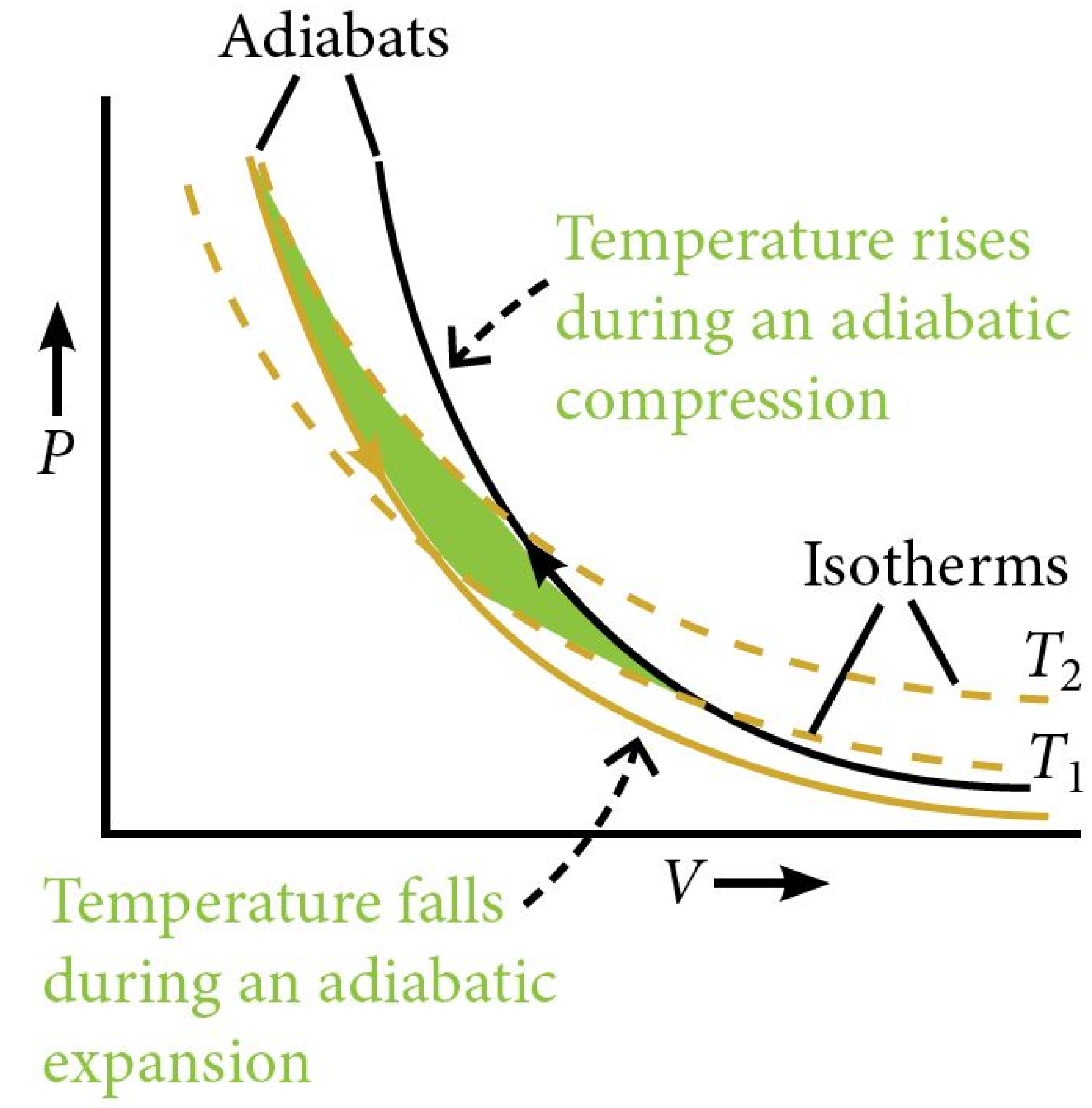
Combinations of Isothermal & Adiabatic Processes

All engines employ a thermodynamic cycle

$w = \pm$ (area under each PV curve)

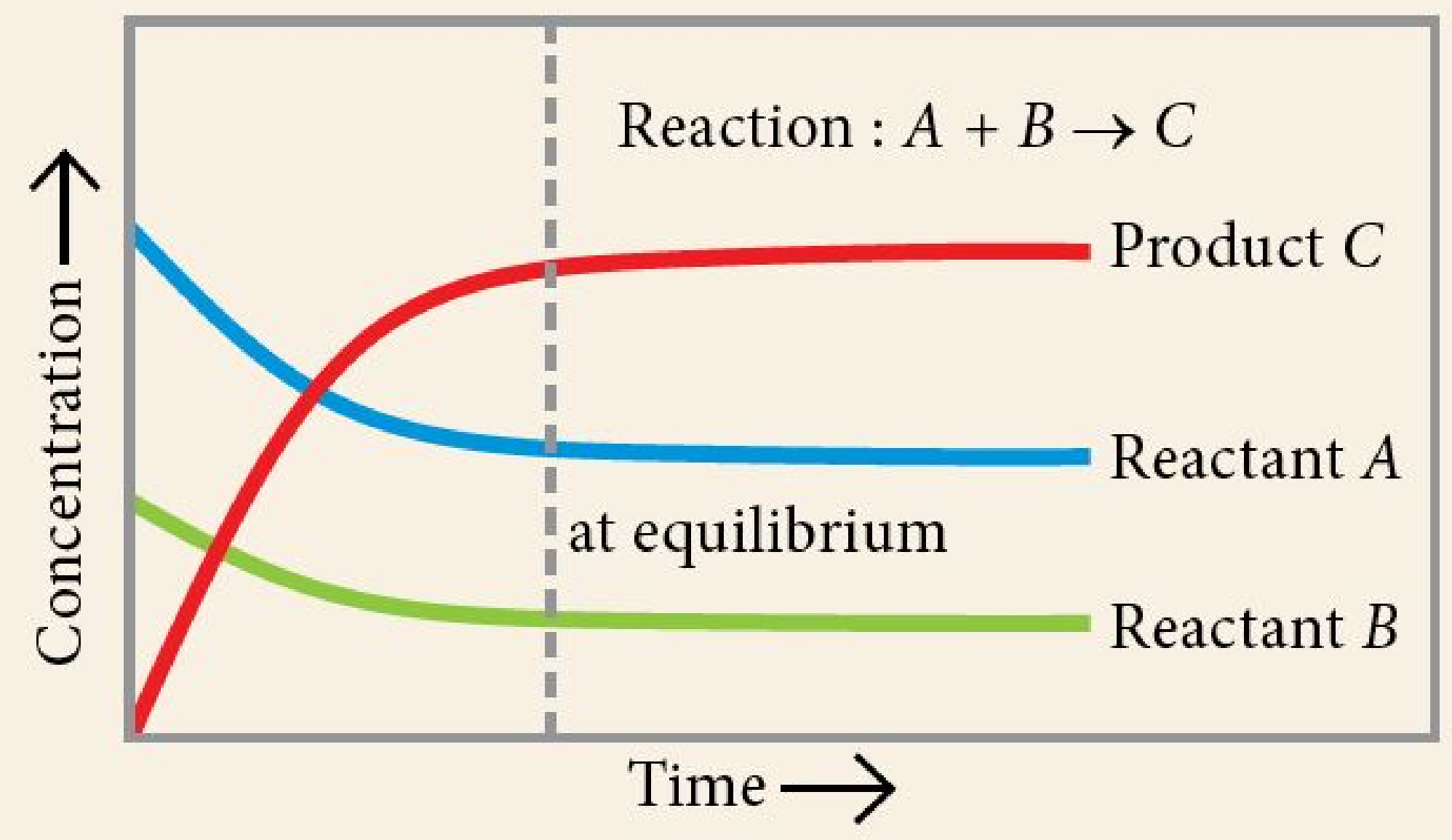
w_{cycle} = area shaded in turquoise

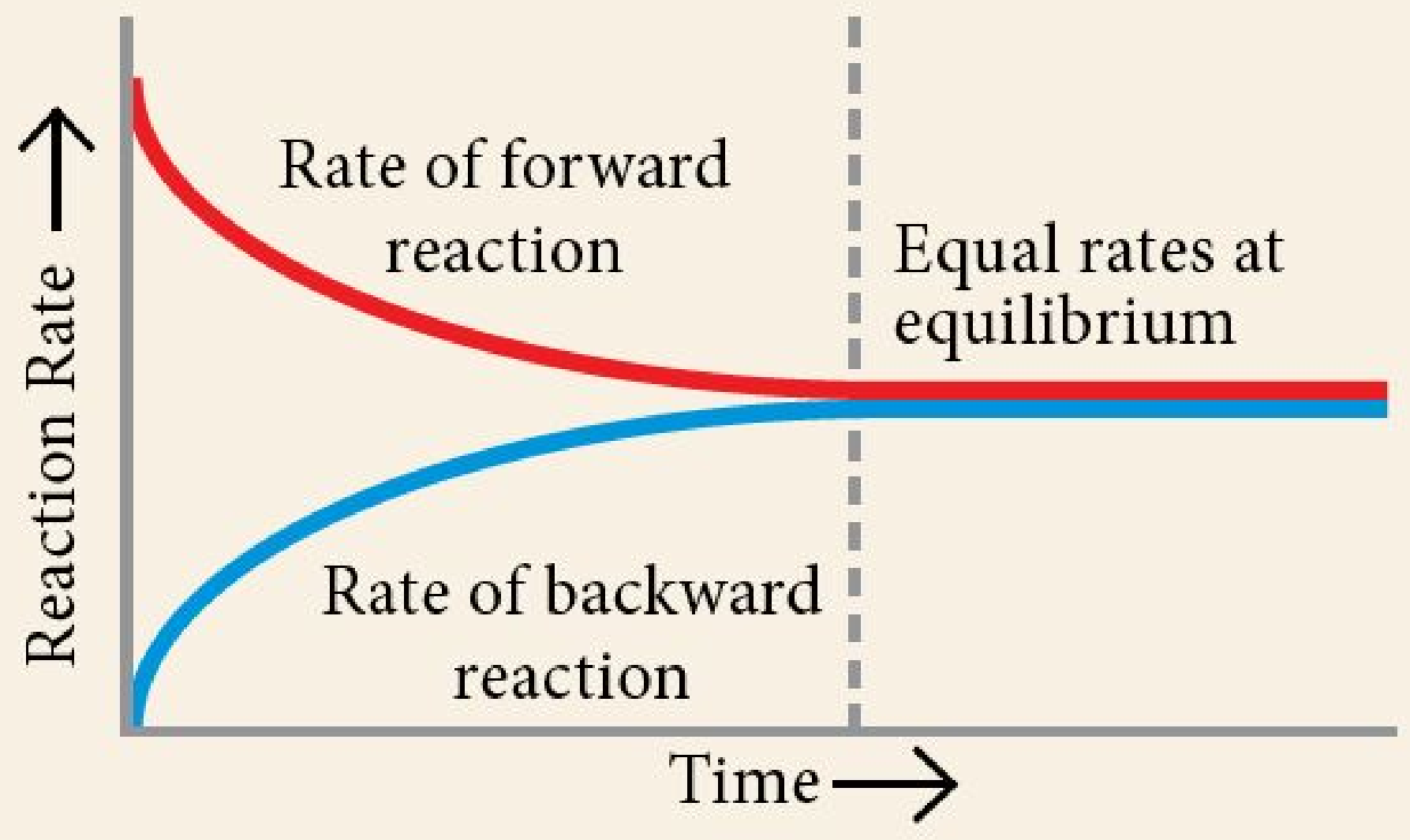




Equilibrium

Equilibrium in Chemical Processes-Dynamic Equilibrium





Henderson Equation

– For an acidic buffer, $\text{pH} = \text{p}K_a + \log\dfrac{[\text{Salt}]}{[\text{Acid}]}$

– For a basic buffer, $\text{pOH} = \text{p}K_b + \log\dfrac{[\text{Salt}]}{[\text{Base}]}$

Salt Hydrolysis

Salts of strong acids and strong bases do not undergo hydrolysis and the resulting solution is neutral.

Salt	Hydrolysis	Nature of solution	Hydrolysis constant (K_h)	Degree of hydrolysis (h)	pH
Weak acid and Strong base	Anionic	Alkaline pH > 7	$K_h = \dfrac{K_w}{K_a}$	$h = \sqrt{\dfrac{K_h}{C}}$	$\text{pH} = \dfrac{1}{2}[\text{p}K_w + \text{p}K_a + \log C]$
Strong acid and Weak base	Cationic	Acidic pH < 7	$K_h = \dfrac{K_w}{K_b}$	$h = \sqrt{\dfrac{K_h}{C}}$	$\text{pH} = \dfrac{1}{2}[\text{p}K_w - \text{p}K_b - \log C]$
Weak acid and Weak base	Anionic and cationic both	Neutral, pH = 7 (If $K_a = K_b$)	$K_h = \dfrac{K_w}{K_a K_b}$	$h = \sqrt{K_h}$	$\text{pH}= \dfrac{1}{2}[\text{p}K_w + \text{p}K_a - \text{p}K_b]$

Solubility vs Solubility Product

	Solubility	Solubility Product
Definition	Property of a substance to dissolve in a solvent.	At a definite temperature, solubility product of an electrolyte is defined as the product of the molar concentrations of its ions in a saturated solution, each concentration raised to the power equal to the number of ions produced on dissociation of one molecule of the electrolyte.
Description	Describes the dissolution of a solute per litre of a solvent. Its unit is gL^{-1}.	It is a thermodynamic constant (K_{sp}) that describes the equilibrium between a solid and its dissolved ions. Its units is mol L^{-1}.
Factors	Depends on several factors such as temperature, pressure, pH, the presence of other chemicals, etc.	Depends only on the temperature.

Electrochemistry

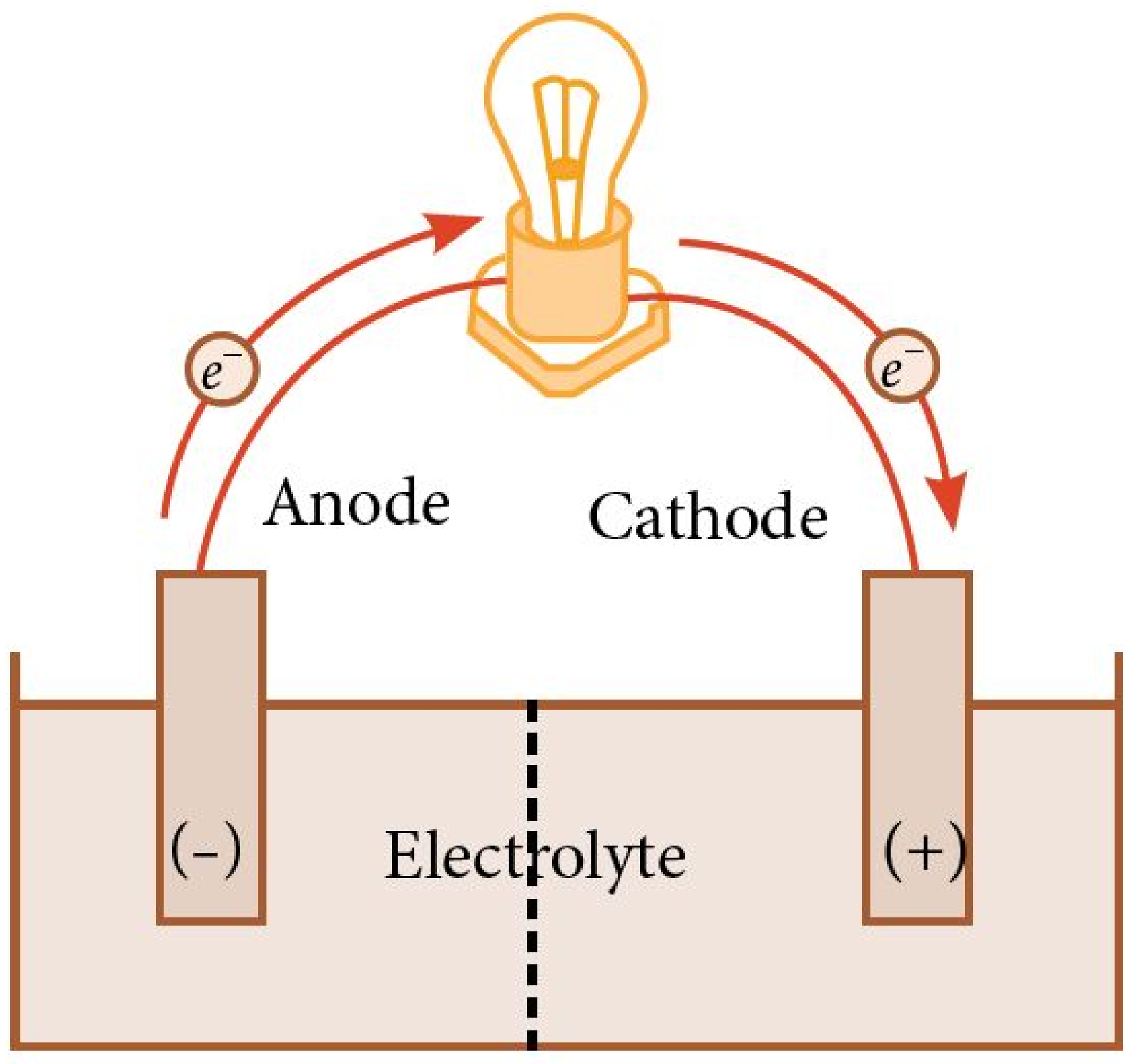
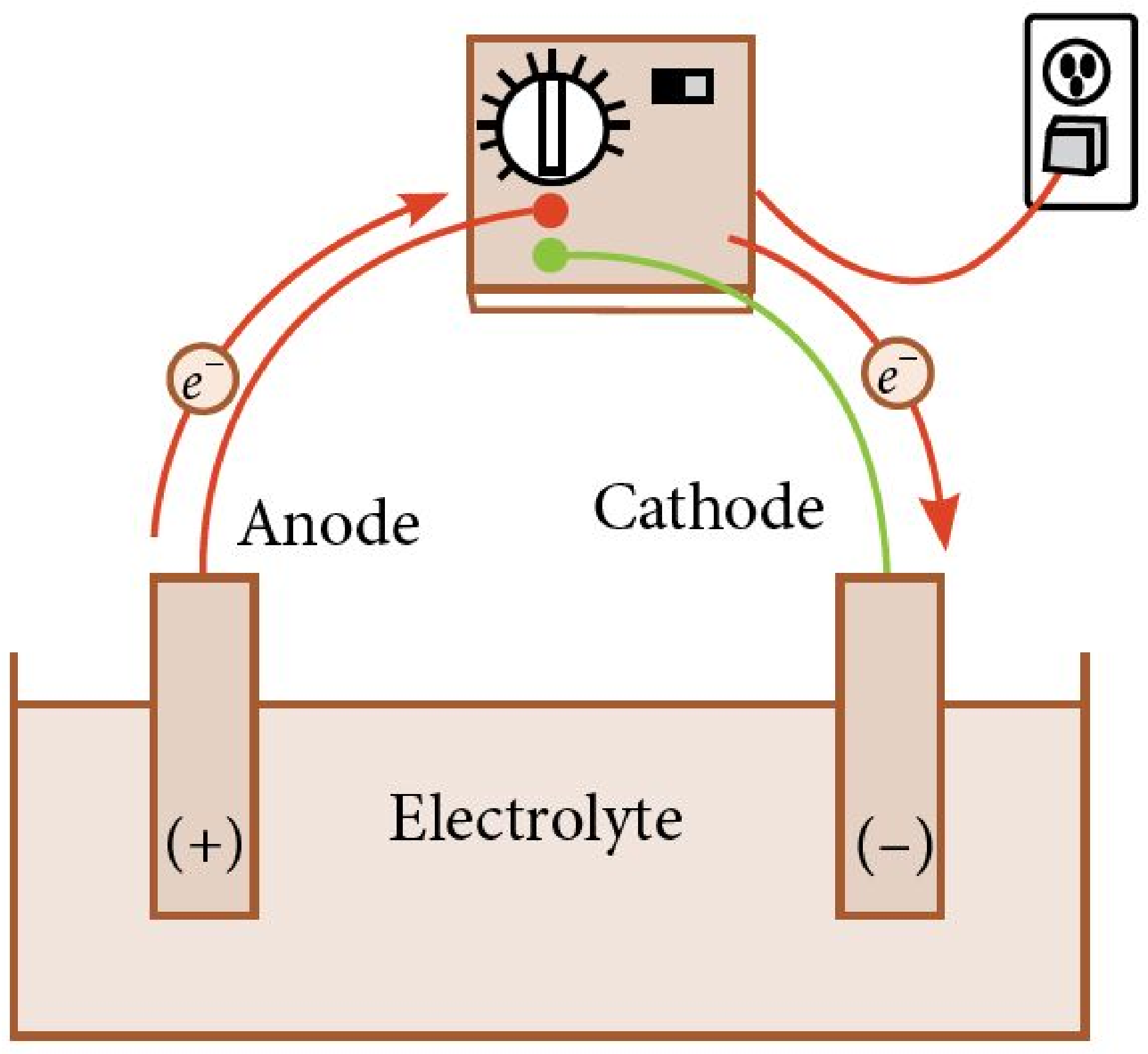
Nernst Equation

$$M^{n+}{}_{(aq)} + ne^- \longrightarrow M_{(s)}$$

$$E_{cell} = E^\circ_{cell} - \frac{RT}{nF}\ln\frac{[M_{(s)}]}{[M^{n+}_{(aq)}]}$$

$$E_{cell} = E^\circ{}_{cell} = \frac{0.0591}{n}, \log\frac{1}{\left[M^{n+}_{(aq.)}\right]}$$

$$\text{Ionic mobility}=\frac{\text{Ionic conductance}}{96500}$$

Galvanic Cell	Electrolytic Cell
Energy released by spontaneous redox reaction is converted to electrical energy.	Electrical energy is used to drive nonspontaneous redox reaction.
Oxidation half-reaction: $Y \rightarrow Y^+ + e^-$	Oxidation half-reaction: $Z^- \rightarrow Z + e^-$
Reduction half-reaction: $Z^+ + e^- \rightarrow Z$	Reduction half-reaction: $Y^+ + e^- \rightarrow Y$
Overall cell reaction: $Y + Z^+ \rightarrow Y^+ + Z\,(G < 0\}$	Overall cell reaction: $Y^+ + Z^- \rightarrow Y + Z\,(G > 0)$
Here, the redox reaction is spontaneous and is responsible for the production of electrical energy.	The redox reaction is non-spontaneous and electrical energy has to be supplied to initiate the reaction.
The two half-cells are set up in different containers, being connected through the salt bridge or porous partition.	Both the electrodes are placed in a same container in the solution of molten electrolyte.
Here the anode is negative and cathode is the positive electrode. The reaction at the anode is oxidation and that at the cathode is reduction.	Here, the anode is positive and cathode is the negative electrode. The reaction at the anode is oxidation and that at the cathode is reduction.
The electrons are supplied by the species getting oxidized. they move from anode to the cathode in the external circuit.	The external battery supplies the electrons. They enter through the cathode and come out through the anode.
	

Concentration cell

$\mathrm{Zn}|\mathrm{Zn}^{2+}(C_1)\,||\,\mathrm{Zn}^{2+}(C_2)\,|\,\mathrm{Zn}$; $\boxed{E_{cell} = \dfrac{0.0591}{n}\log\dfrac{C_2}{C_1}}$ (Where $C_2 > C_1$)

Chemical Kinetics

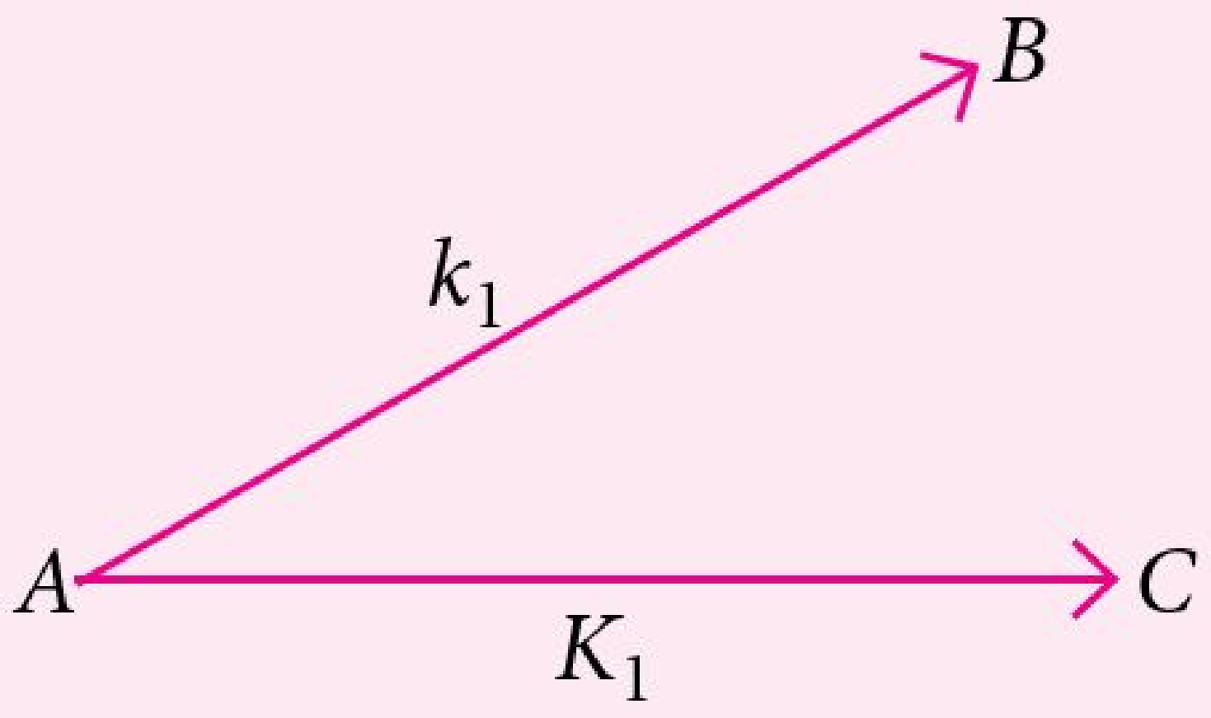
Reaction	Order	Integrated rate equation	Graph (Straight line obtained by plotting conc. *vs.* time)	$t_{1/2}$ proportional to
$A \rightarrow$ Products	0	$k = \frac{1}{t}\{[A_0] - [A]\}$ or, $k = \frac{x}{t}$	$a - x$; slope = $-k$	a
$A \rightarrow$ Products	1	$k = \frac{2.303}{t}\log\frac{a}{a-x}$	$\log(a - x)$; slope = $\frac{-k}{2.303}$	independent of a
$2A \rightarrow$ Products	2	$k = \frac{x}{ta(a-x)}$	$\frac{1}{(a-x)}$; slope = k	$\frac{1}{a}$
$nA \rightarrow$ Products	n	$k = \frac{1}{t(n-1)}\left[\frac{1}{(a-x)^{n-1}} - \frac{1}{a^{n-1}}\right]$	$\frac{1}{(a-x)^{n-1}}$; slope = k	$\frac{1}{a^{n-1}}$

Rate Law for Reversible Reaction

$$A_2 + B_2 \underset{k_2}{\overset{k_1}{\rightleftharpoons}} 2AB; \quad \text{Rate} = k_1 [A_2][B_2] - k_2 [AB]^2$$

Rate Law for Parallel Reaction

$$\text{Rate} = (k_1 + k_2)[A]$$



For a Zero Order Reaction

$$t_{100\%} = \frac{[A]_0}{k};$$

$$t_{3/4} = 1.5\, t_{1/2}$$

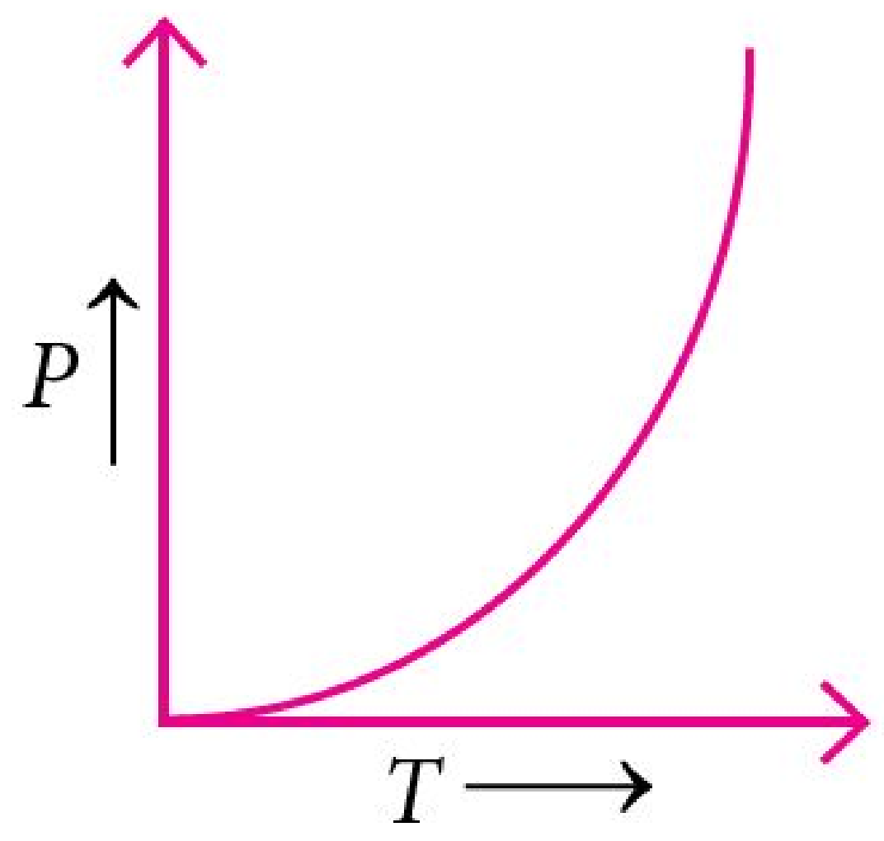
Arrhenius Equation

$$k = Ae^{-E_a/RT}$$

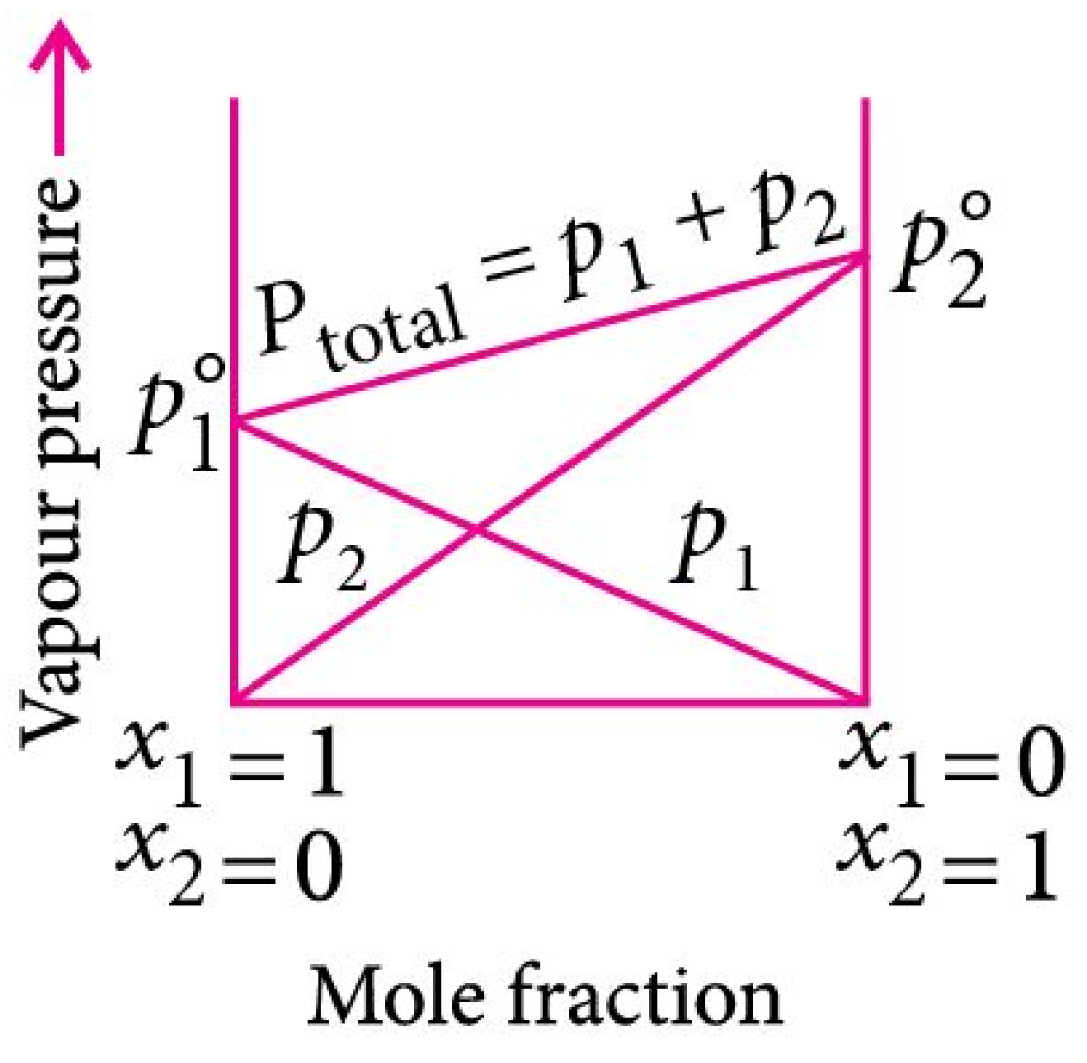
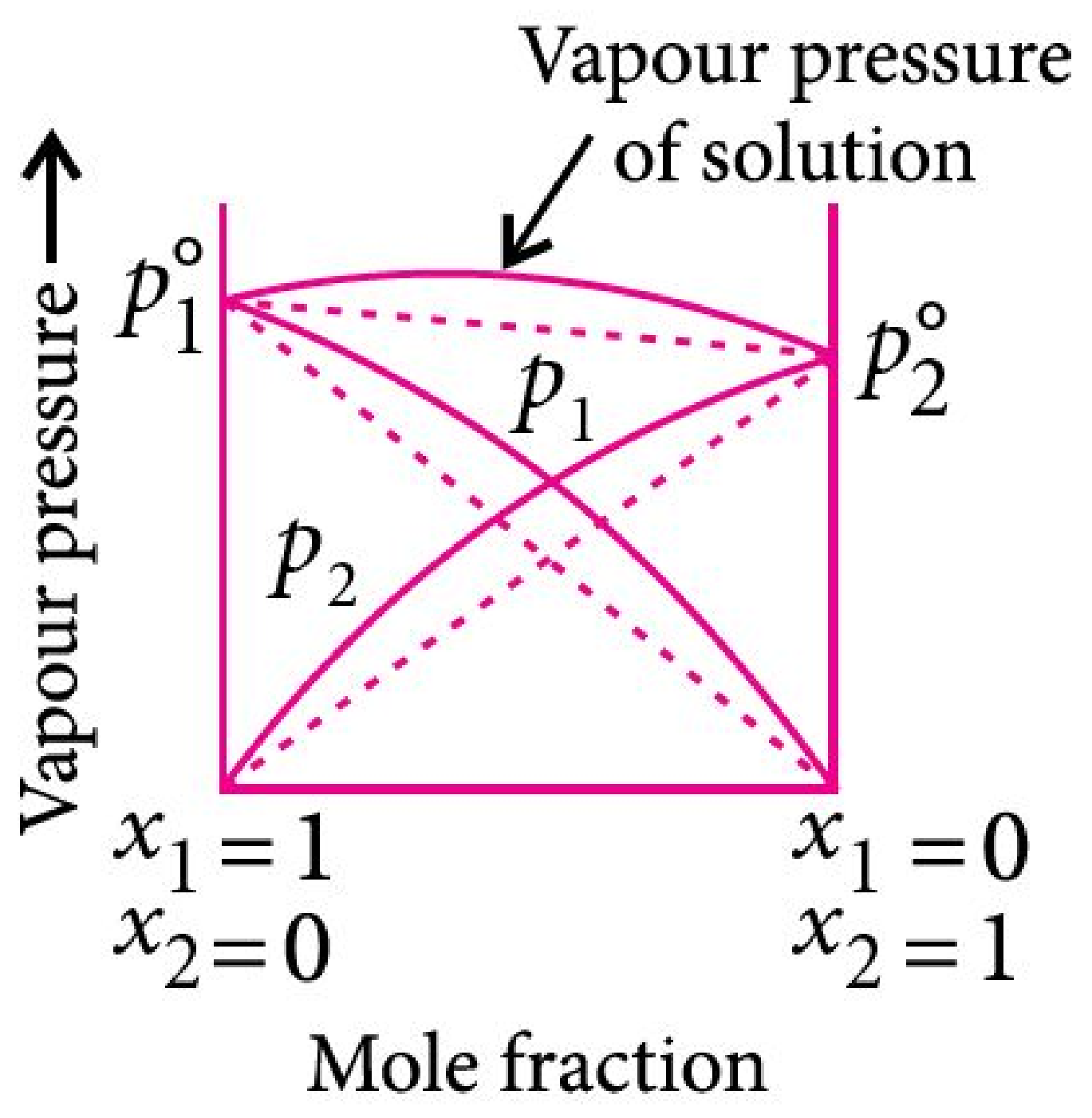
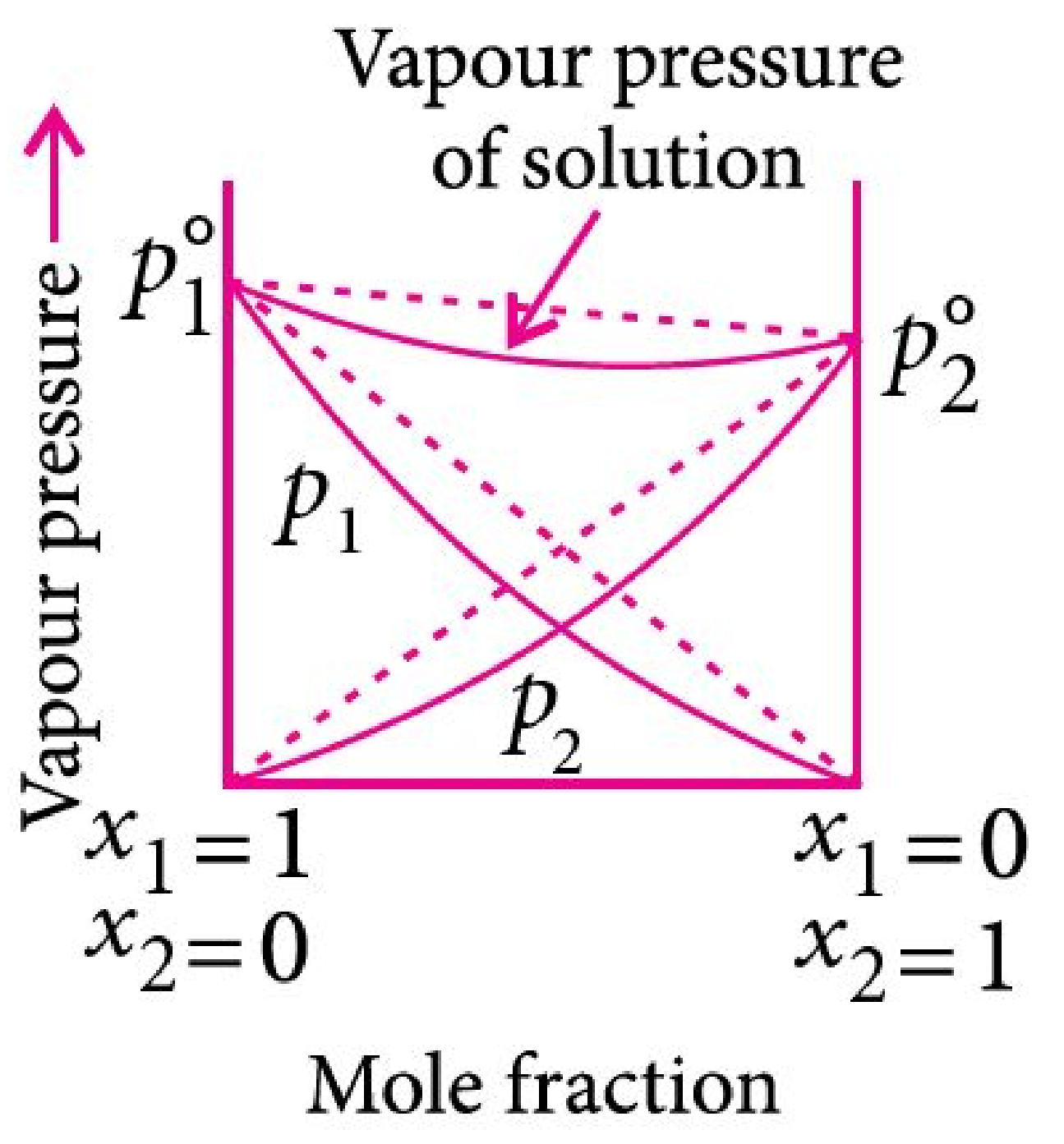
Solution

Effect of temperature on Vapour Pressure of Liquid (Clausius-Clapeyron Equation)

$$\log \frac{p_2}{p_1} = \frac{\Delta H_{\text{vap}}}{2.303R}\left[\frac{T_2 - T_1}{T_1 T_2}\right]$$

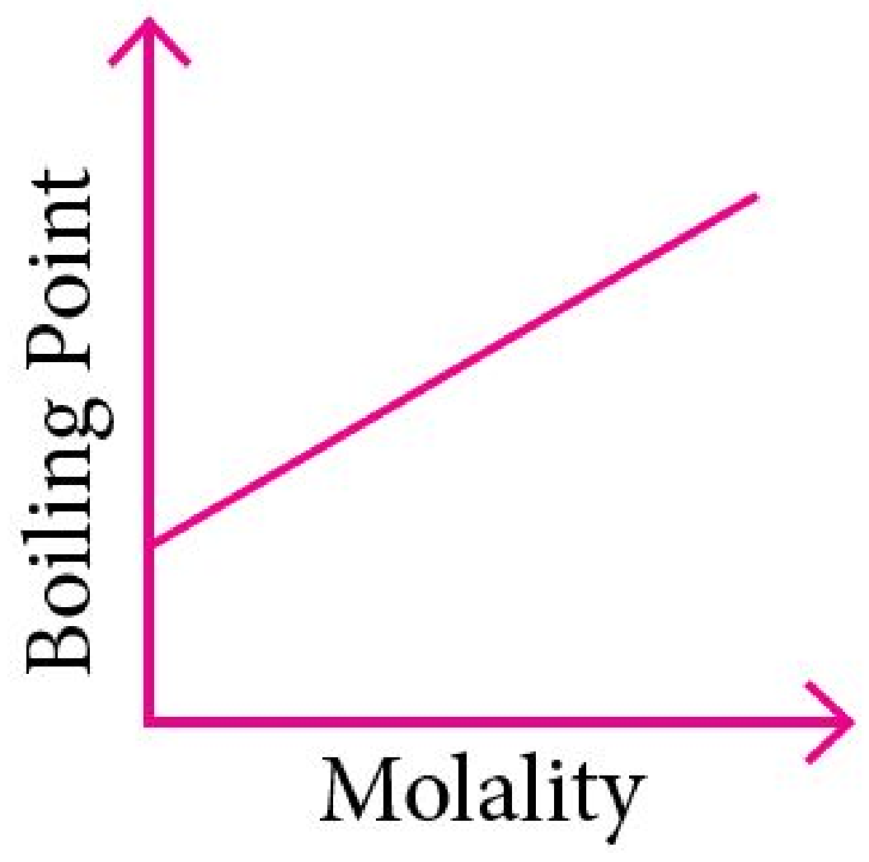


Ideal and Non-ideal Solutions

Ideal solutions	Non-ideal solutions	
	Positive deviation from Raoult's law	**Negative deviation from Raoult's law**
 	 	
$A - B \approx A - A$ and $B - B$ interactions	$A - B << A - A$ and $B - B$ interactions	$A - B >> A - A$ and $B - B$ interactions
$\Delta H_{\text{mix}} = 0, \Delta V_{\text{mix}} = 0$	$\Delta H_{\text{mix}} > 0, \Delta V_{\text{mix}} > 0$	$\Delta H_{\text{mix}} < 0, \Delta V_{\text{mix}} < 0$

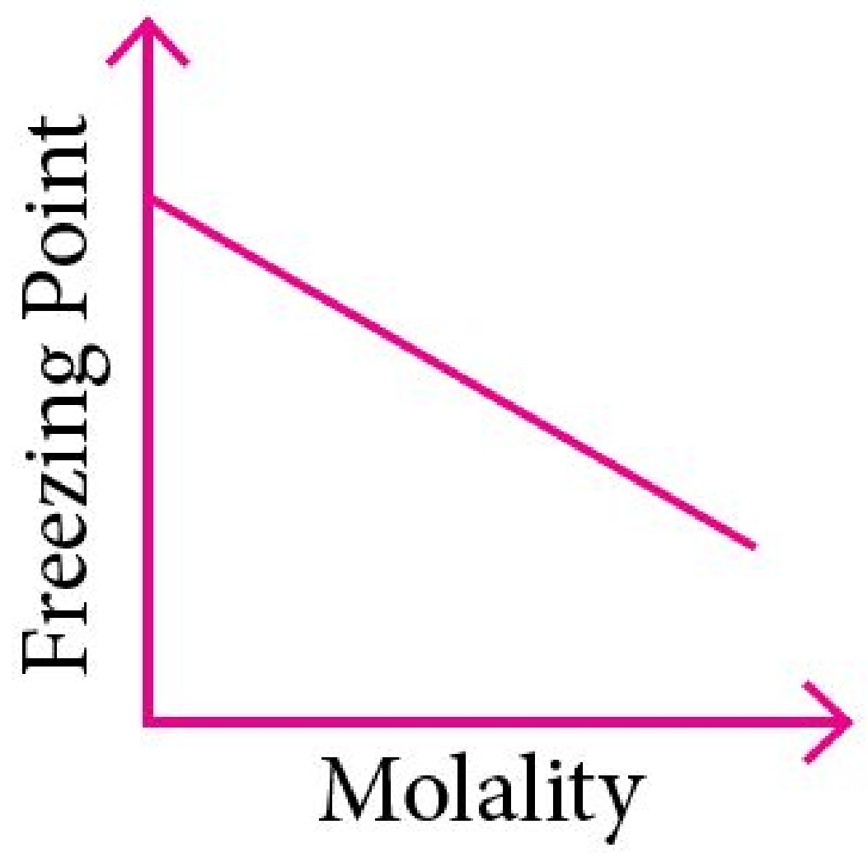
Variation of elevation in b.pt. with molality

$$T_b = T_b^\circ + K_b m$$



Variation of depression in freezing point with molality

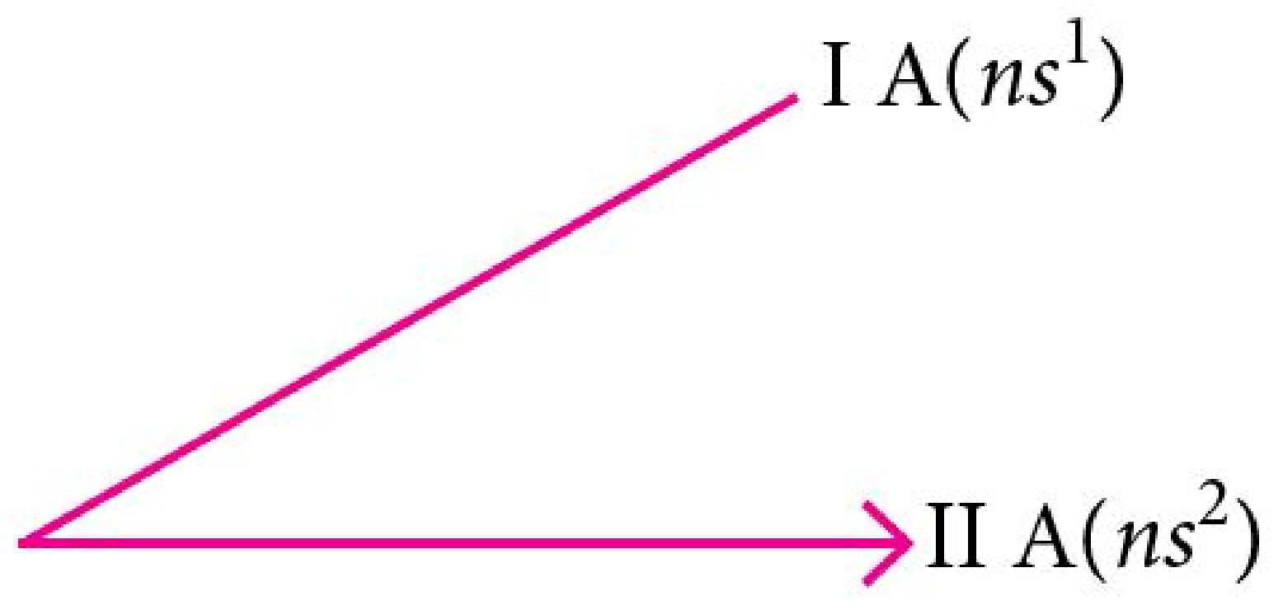
$$T_f = T_f^\circ + K_f m$$



INORGANIC CHEMISTRY

s-Block Element

- Last e^- enters the s-orbitals
- s block



Important Trends

- Some general trends of alkali metals and their compounds :
  - Electropositive character : $Li < Na < K < Rb < Cs$
  - Hydration enthalpy : $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$
  - Reducing character : $Na < K < Rb < Cs < Li$
- Some general trends of alkaline earth metals and their compounds :
  - Hydration enthalpy : $Be^{2+} > Mg^{2+} > Ca^{2+} > Sr^{2+} > Ba^{2+}$
  - Reducing character : $Be < Mg < Ca < Sr < Ba < Ra$
- Order of hydration of ions :

$Cs^+ < Ba^{2+} < Rb^+ < Sr^{2+} < K^+ < Ca^{2+} < Na^+ < Mg^{2+} < Li^+ < Be^{2+}$

- Thermal stability of hydrides :

Group - IA : $LiH > NaH > KH > RbH > CsH$

Group - IIA : $BeH_2 > MgH_2 > CaH_2 > SrH_2 > BaH_2$

- Order of basic character of hydroxides :

Group - IA : $CsOH > RbOH > KOH > NaOH > LiOH$

Group - IIA : $Ba(OH)_2 > Sr(OH)_2 > Ca(OH)_2 > Mg(OH)_2 > Be(OH)_2$

- Thermal stability of metal carbonates :

Group - IA : $Rb_2CO_3 > K_2CO_3 > Na_2CO_3 > Li_2CO_3$

Group - IIA : $BaCO_3 > SrCO_3 > CaCO_3 > MgCO_3 > BeCO_3$

  - Stability of bicarbonates :
  - $NaHCO_3 < KHCO_3 < RbHCO_3 < CsHCO_3$ ($LiHCO_3$ does not exist as a solid.)
  - Solubility of carbonates :

$BeCO_3 > MgCO_3 > CaCO_3 > \underbrace{SrCO_3 > BaCO_3}_{\text{Almost insoluble}}$

- Solubility of hydroxides in water :

Group - IA : $CsOH > RbOH > KOH > NaOH > LiOH$

Group - IIA : $Ba(OH)_2 > Sr(OH)_2 > Ca(OH)_2 > Mg(OH)_2$.

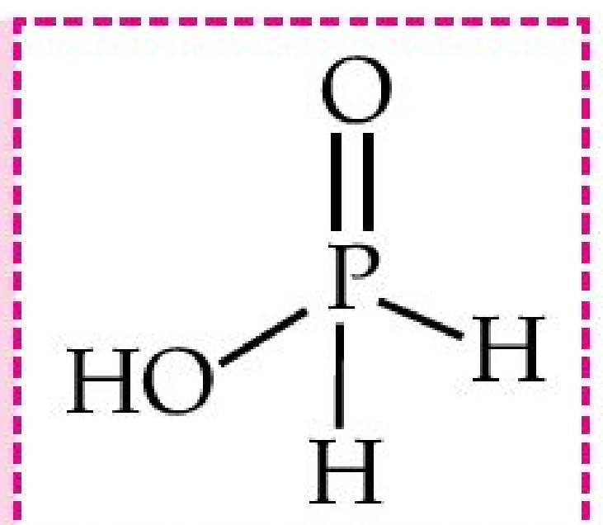
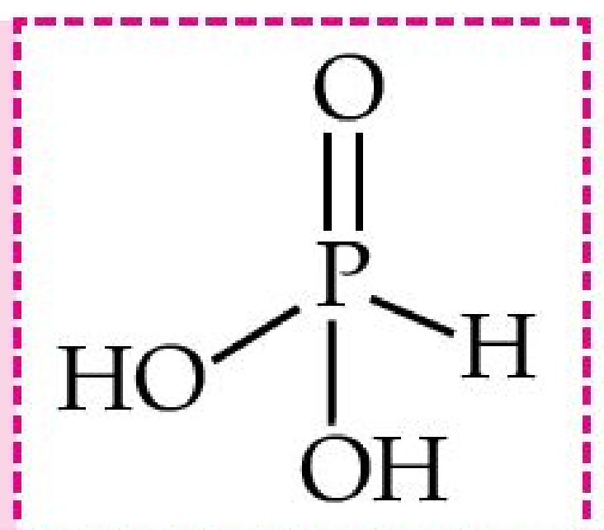
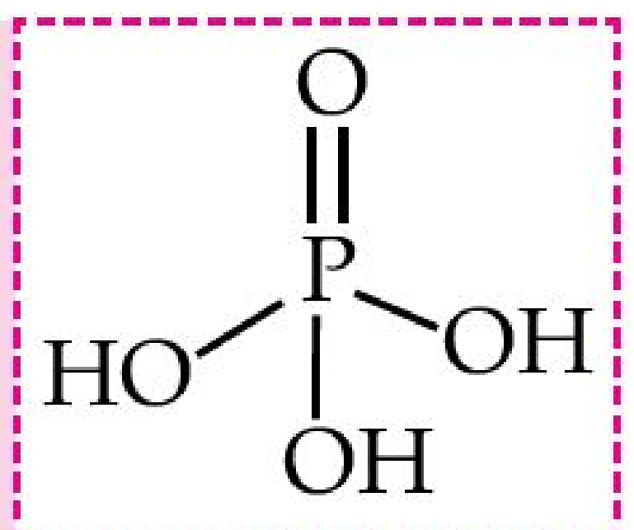
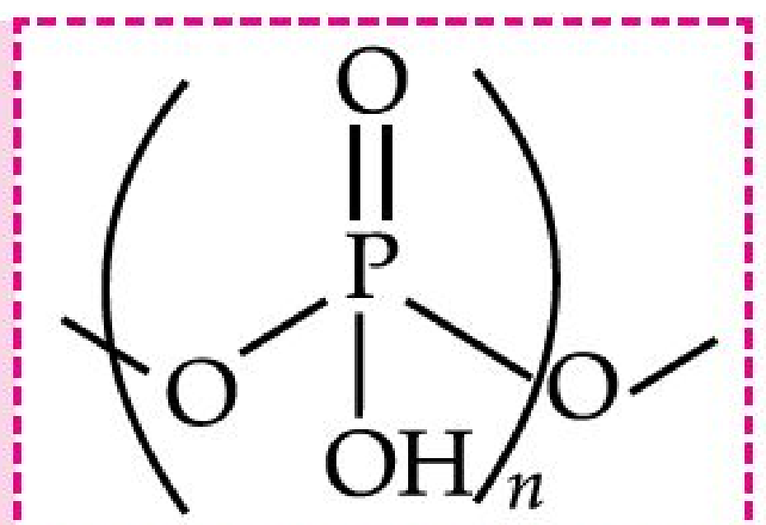
- Solubility of sulphates in water :

Group-II A : $BeSO_4 > MgSO_4 > CaSO_4 > SrSO_4 > BaSO_4$

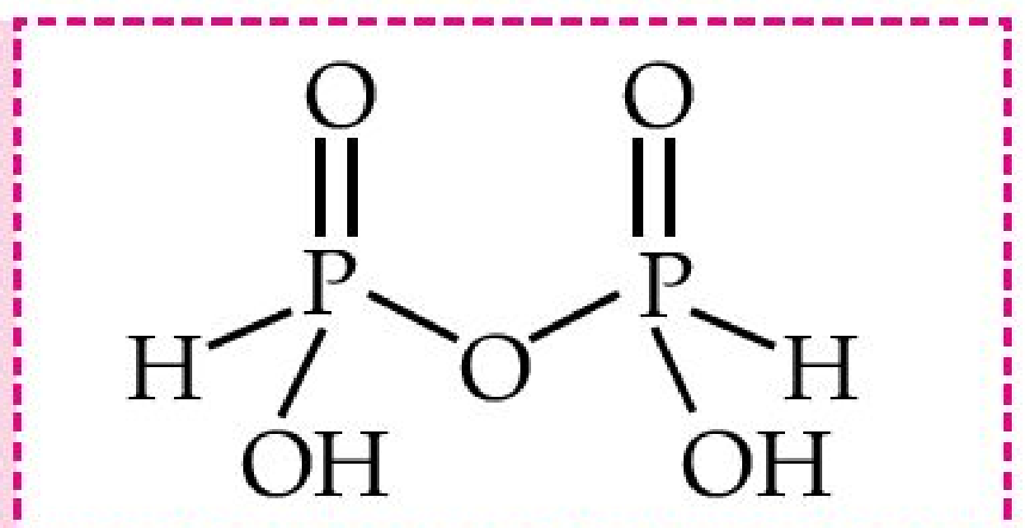
- The stability of alkali metal hydrides decreases from LiH to CsH.
- The solubility of some halides in water follows the order :
  - $BeF_2 > MgF_2 > CaF_2 > SrF_2 > BaF_2$
  - $BeCl_2 < MgCl_2 < CaCl_2 < SrCl_2 < BaCl_2$
  - $CaF_2 < CaCl_2 < CaBr_2 < CaI_2$

p-Block Element

Oxoacids of Phosphorus

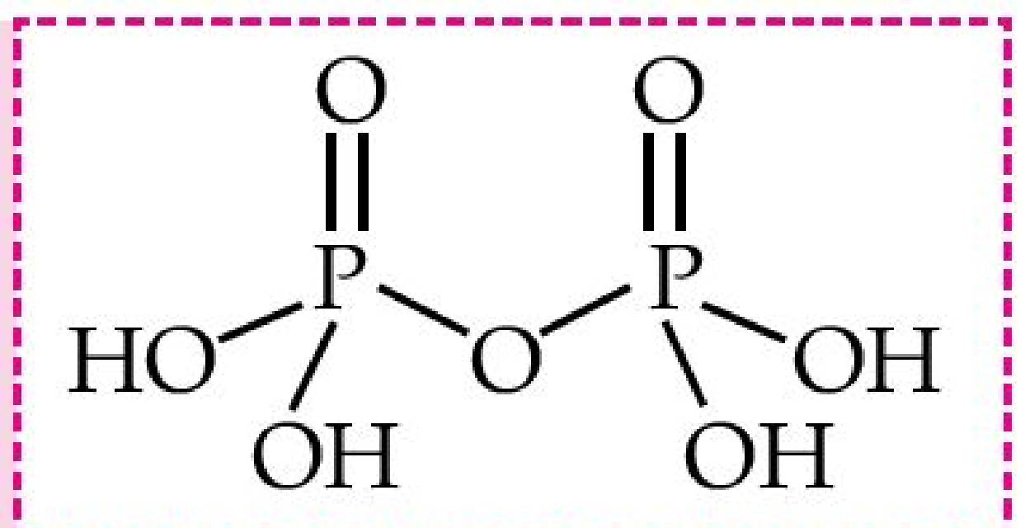
Basicity = 1 O.S. of P = +1		Phosphinic acid (Hypophosphorous acid), H_3PO_2
Basicity = 2 O.S. of P = +3		Phosphonic acid (Orthophosphorous acid or phosphorous acid), H_3PO_3
Basicity = 3 O.S. of P = +5		Phosphoric acid (Orthophosphoric acid), H_3PO_4
Basicity = 1 O.S. of P = +5		Metaphosphoric acid (Glacial phosphoric acid), $(HPO_3)_n$

Basicity = 2
O.S. of P = +3


O
O
H
P
O
P
H
OH
OH

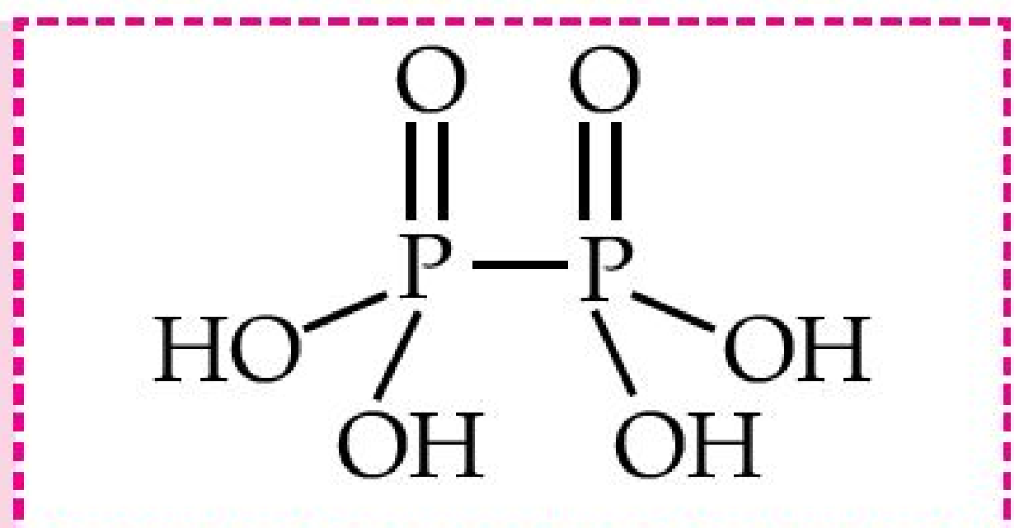
Pyrophosphorous acid
(Diphosphorous acid), $H_4P_2O_5$

Basicity = 4
O.S. of P = +5


O
O
HO
P
O
P
OH
OH
OH

Pyrophosphoric acid
(Diphosphoric acid), $H_4P_2O_7$

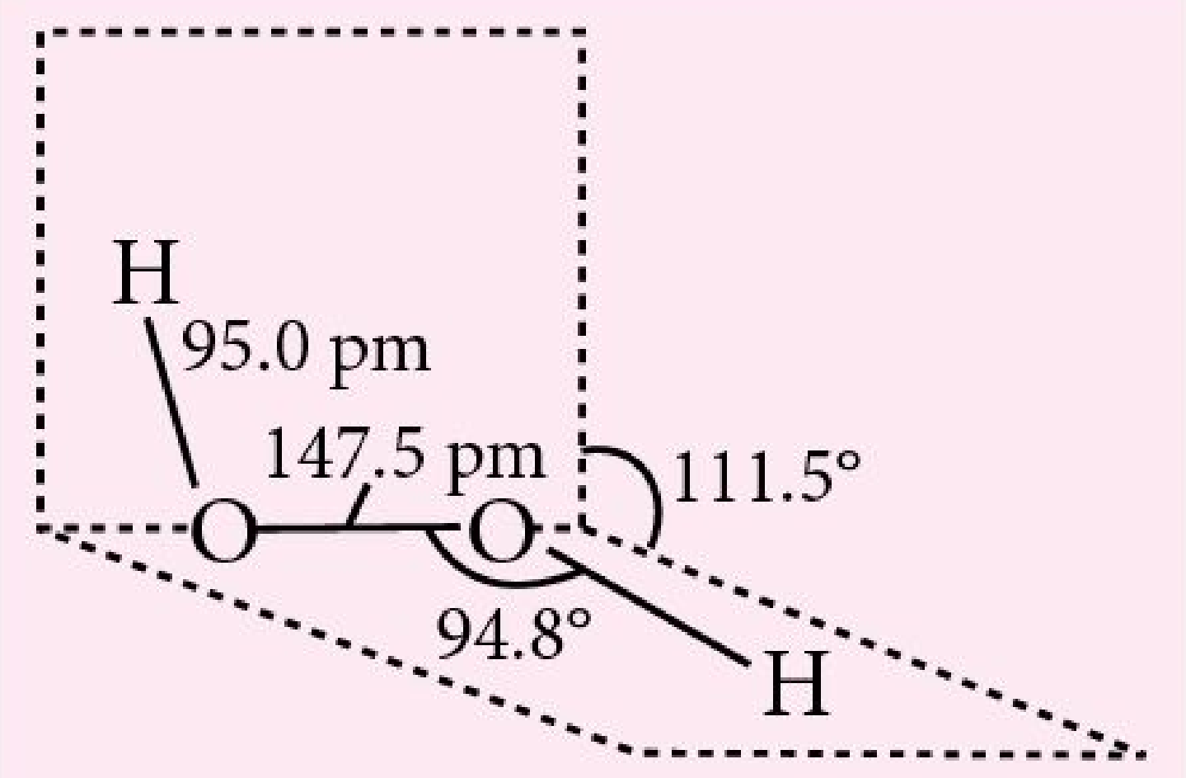
Basicity = 4
O.S. of P = +4


O
O
HO
P
P
OH
OH
OH

Hypophosphoric acid,
$H_4P_2O_6$

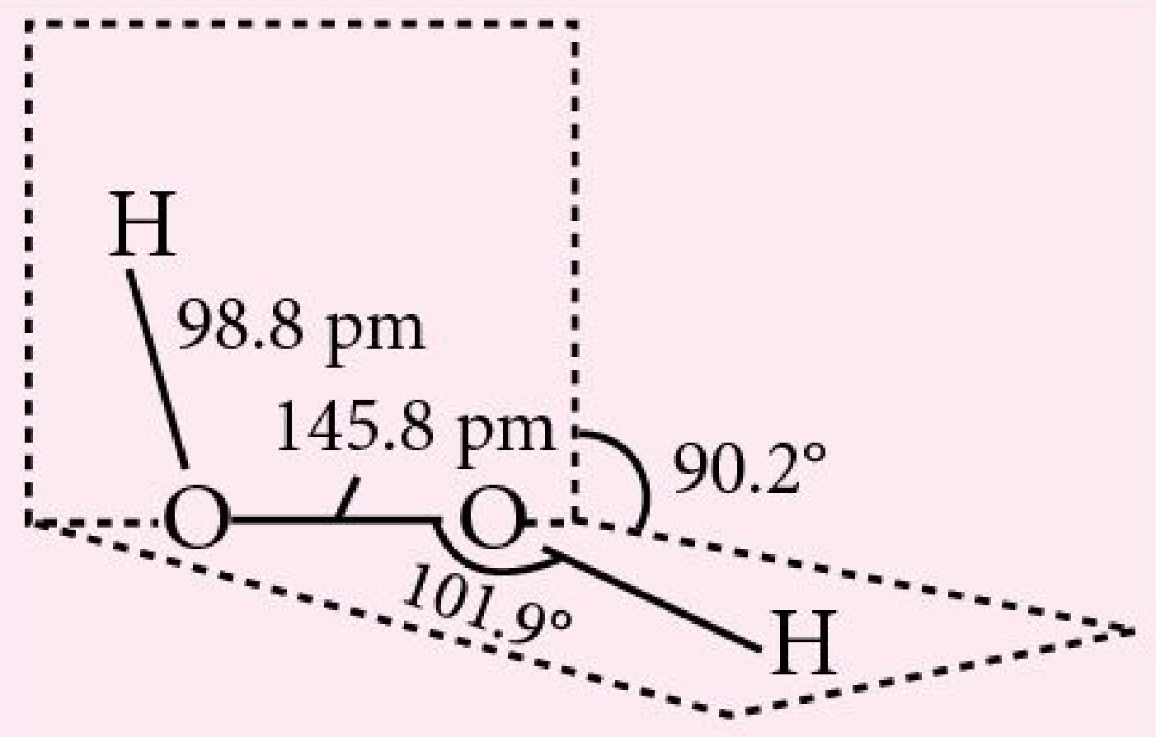
Structure of H_2O_2

Structure of H_2O_2 is slightly different in gas phase and crystalline phase.


H
95.0 pm
147.5 pm
111.5°
O
O
94.8°
H

(In gas phase)

,


H
98.8 pm
145.8 pm
90.2°
O
O
101.9°
H

(In solid phase (110 K))

Strength of Hydrogen Peroxide Solution

Volume Strength of H_2O_2 : Volume strength of H_2O_2 means the volume of O_2 released by decomposition of 1 volume H_2O_2. For example, H_2O_2 of x volume strength means 1 mL or 1 L of H_2O_2 on decomposition gives x mL or x L of oxygen respectively.

$$\underset{2 \times 34\text{ g}}{2H_2O_2} \longrightarrow 2H_2O + \underset{22.4\text{ L at STP}}{O_2}$$

i.e., 22.4 L of oxygen is released from 68 g H_2O_2, then x L of oxygen will be released from

$$= \frac{68}{22.4} \times x = \frac{17x}{5.6} \text{ g of } H_2O_2; \quad \text{Strength} = \frac{17x}{5.6} \text{ g/L}$$

$$\text{Normality} = \frac{\text{Strength}}{\text{Equivalent weight}} = \frac{17x}{5.6} \times \frac{1}{17} = \frac{x}{5.6}$$

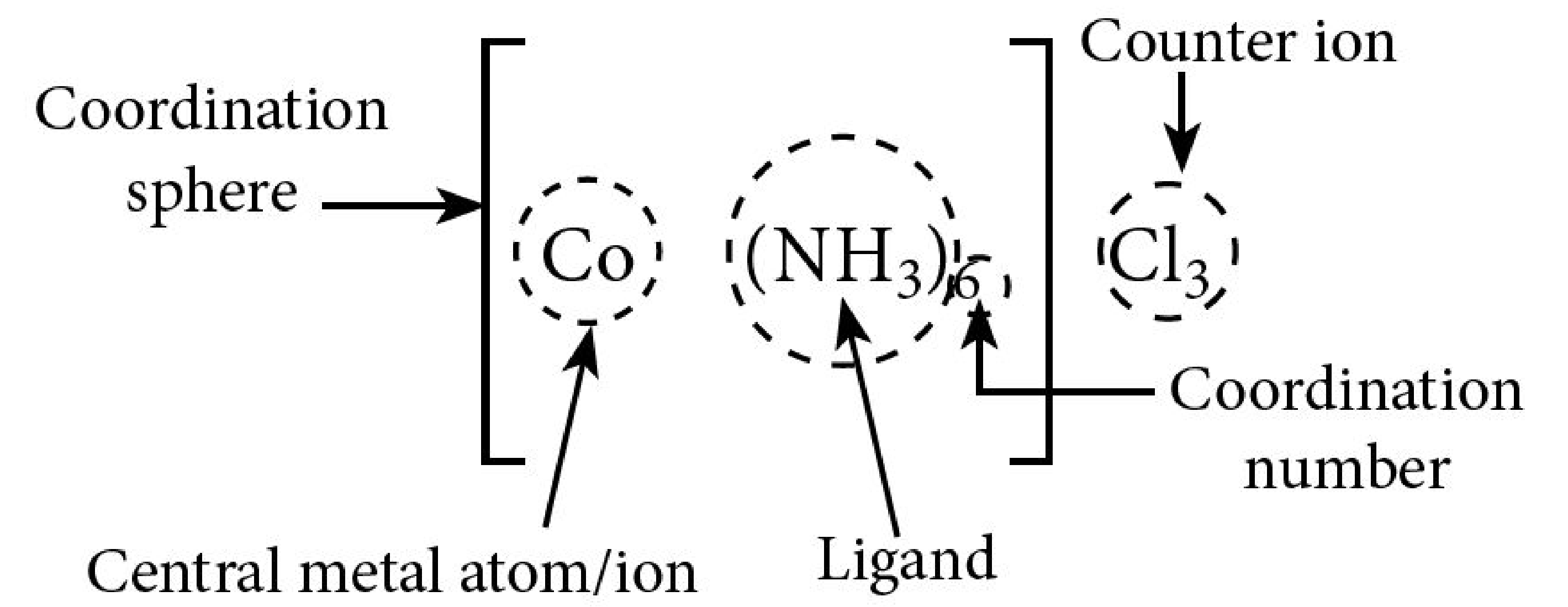
$\therefore$ Normality of H_2O_2 solution

$$= \frac{\text{Volume strength of } H_2O_2}{5.6}$$

$$\text{Molarity} = \frac{\text{Normality}}{2} = \frac{x}{11.2} \quad \text{(Valency factor = 2)}$$

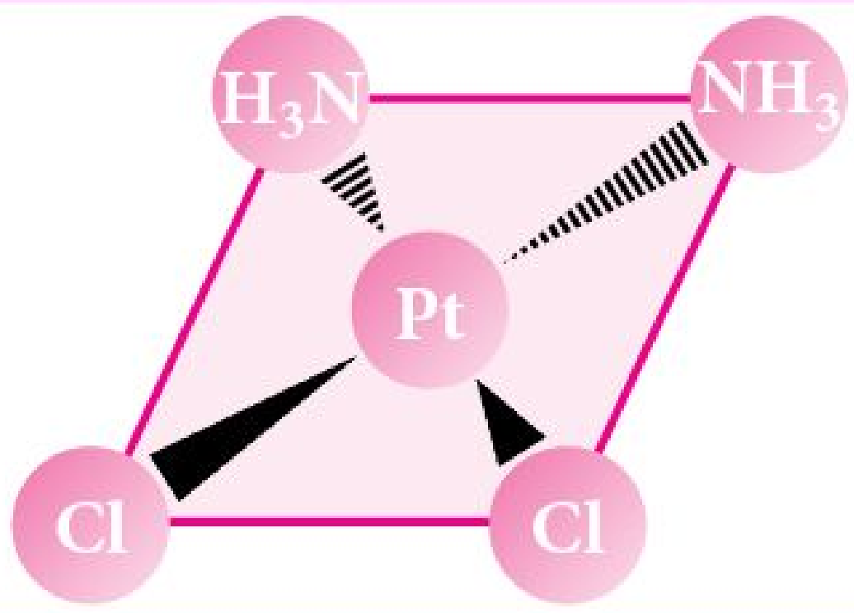
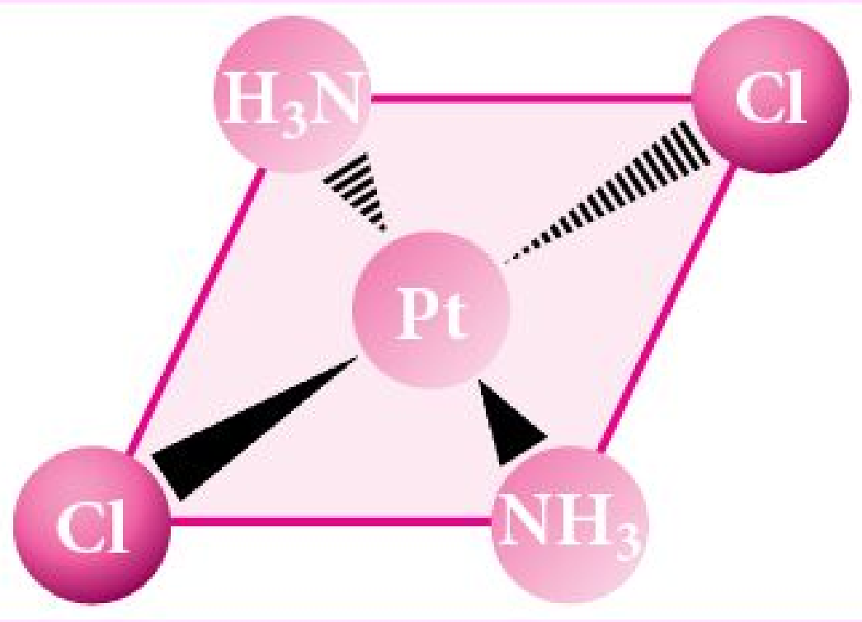
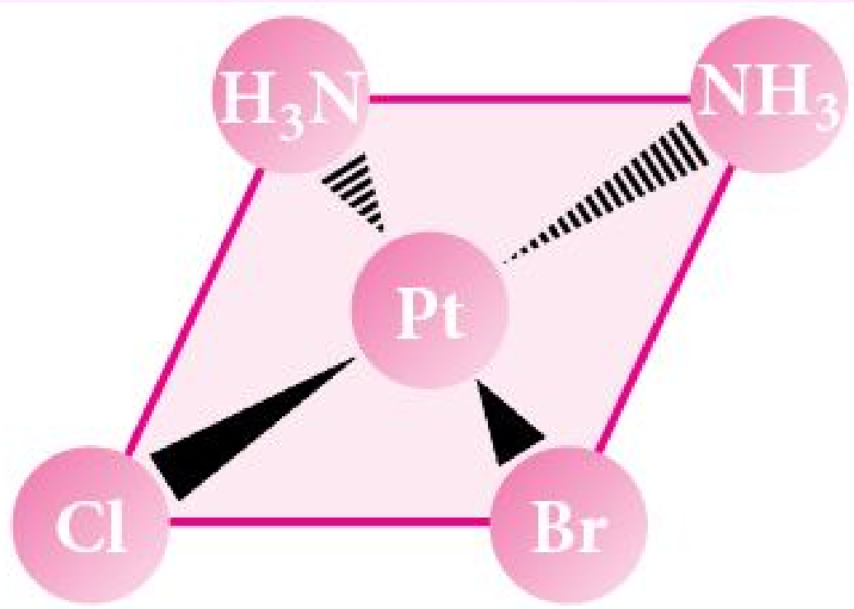
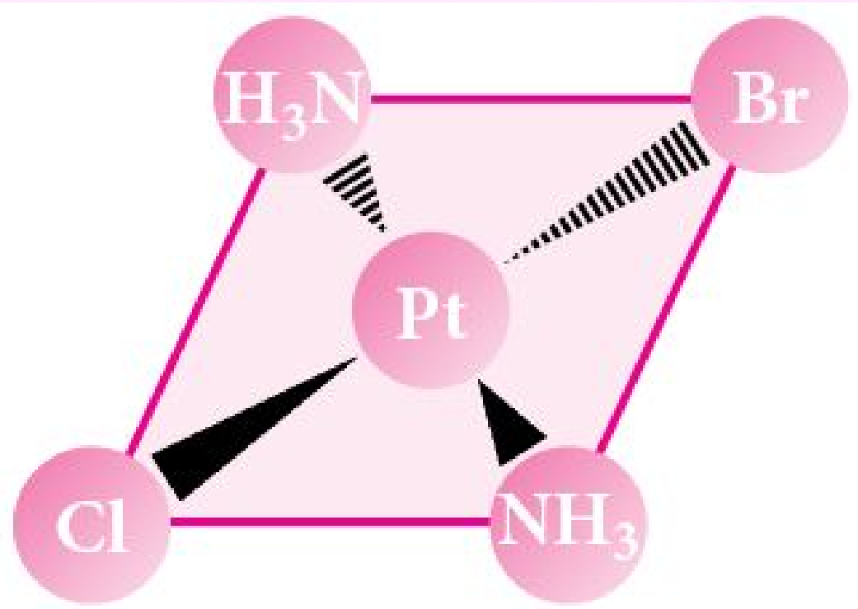
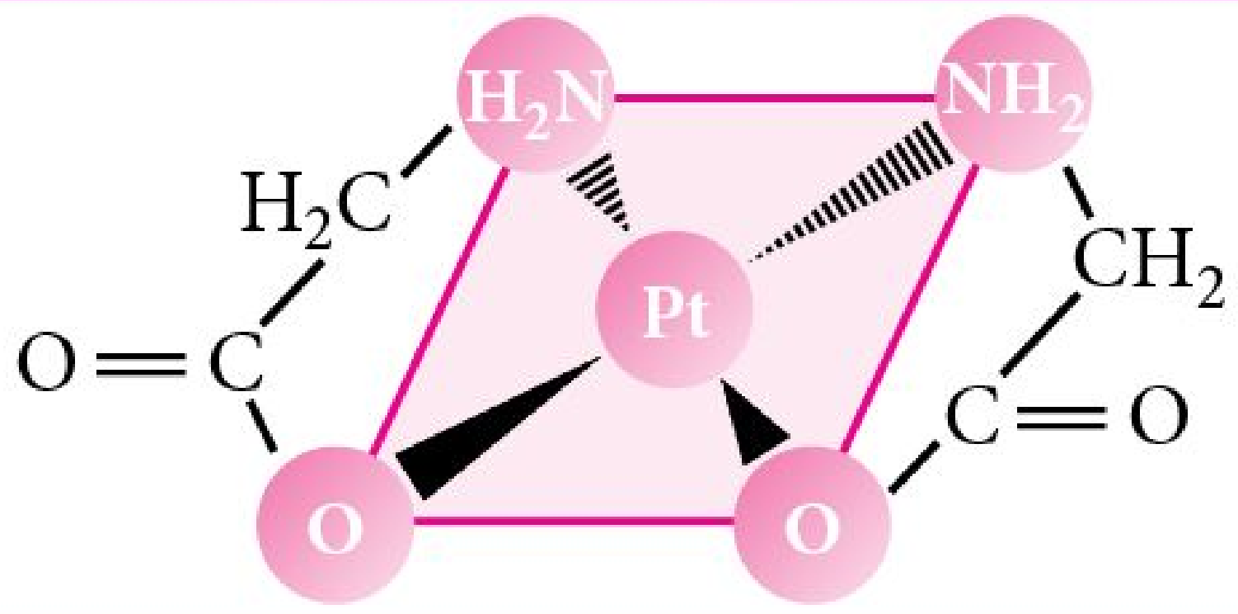
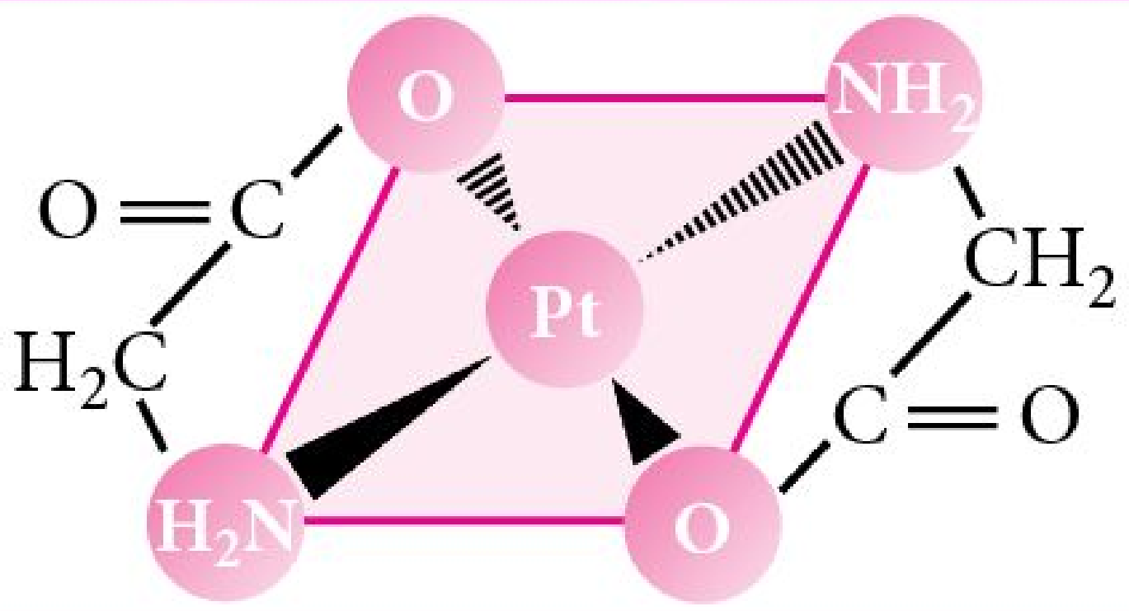
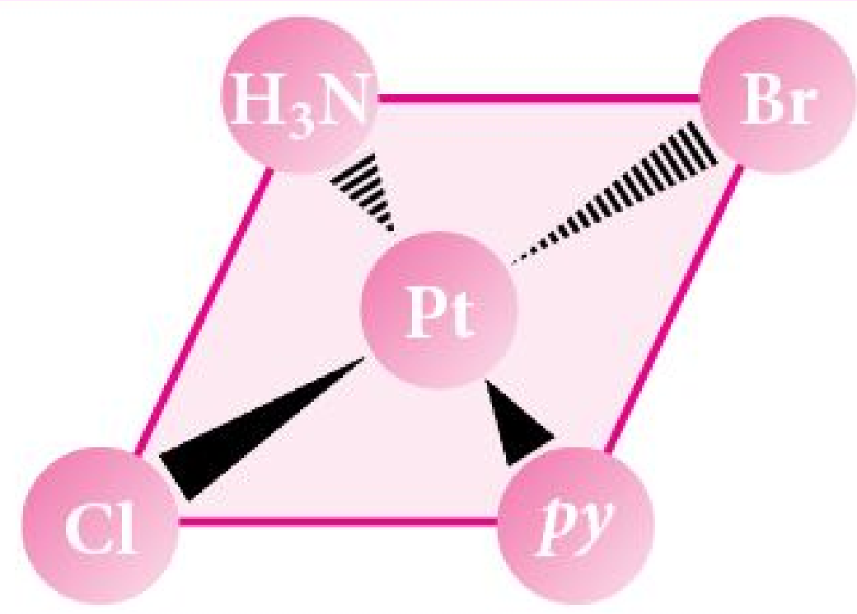
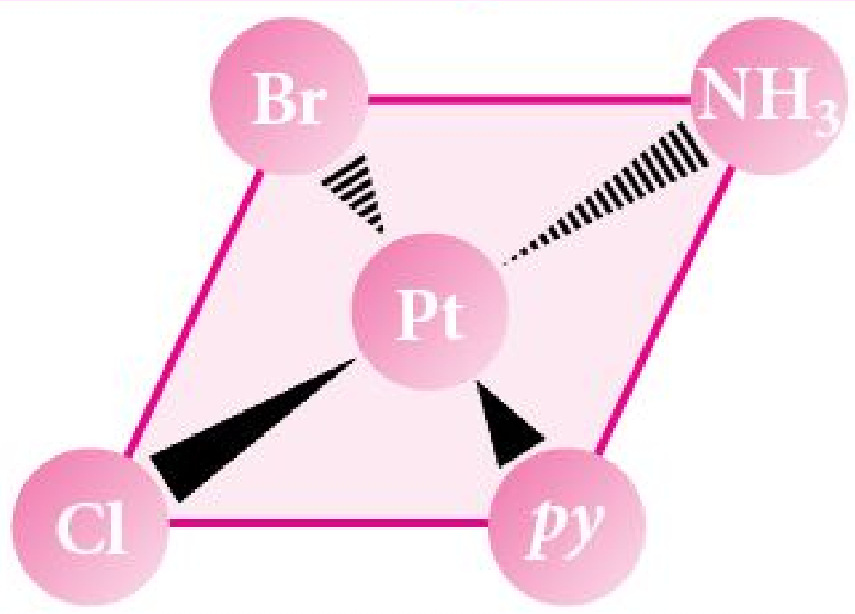
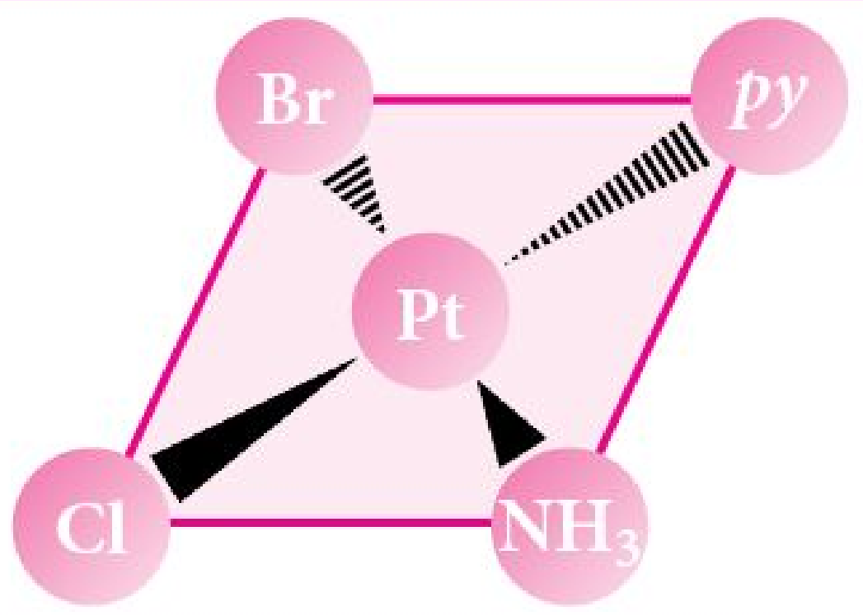
$$\therefore \text{Molarity of } H_2O_2 \text{ solution} = \frac{\text{Volume strength of } H_2O_2}{11.2}$$

Coordination Chemistry

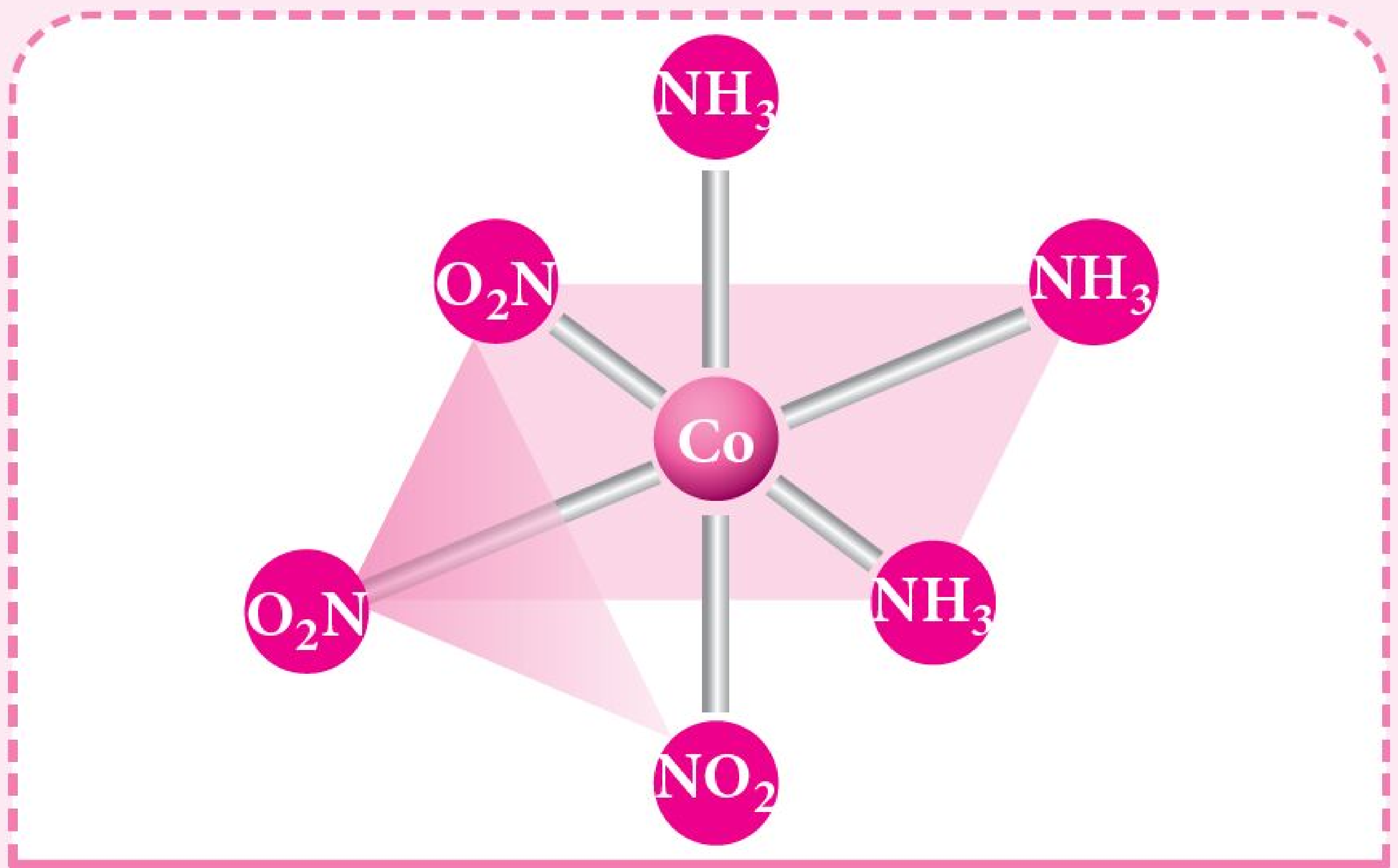

Coordination sphere
Counter ion
Co
$(NH_3)_6$
Cl_3
Coordination number
Central metal atom/ion
Ligand

Isomerism in Coordination Compounds

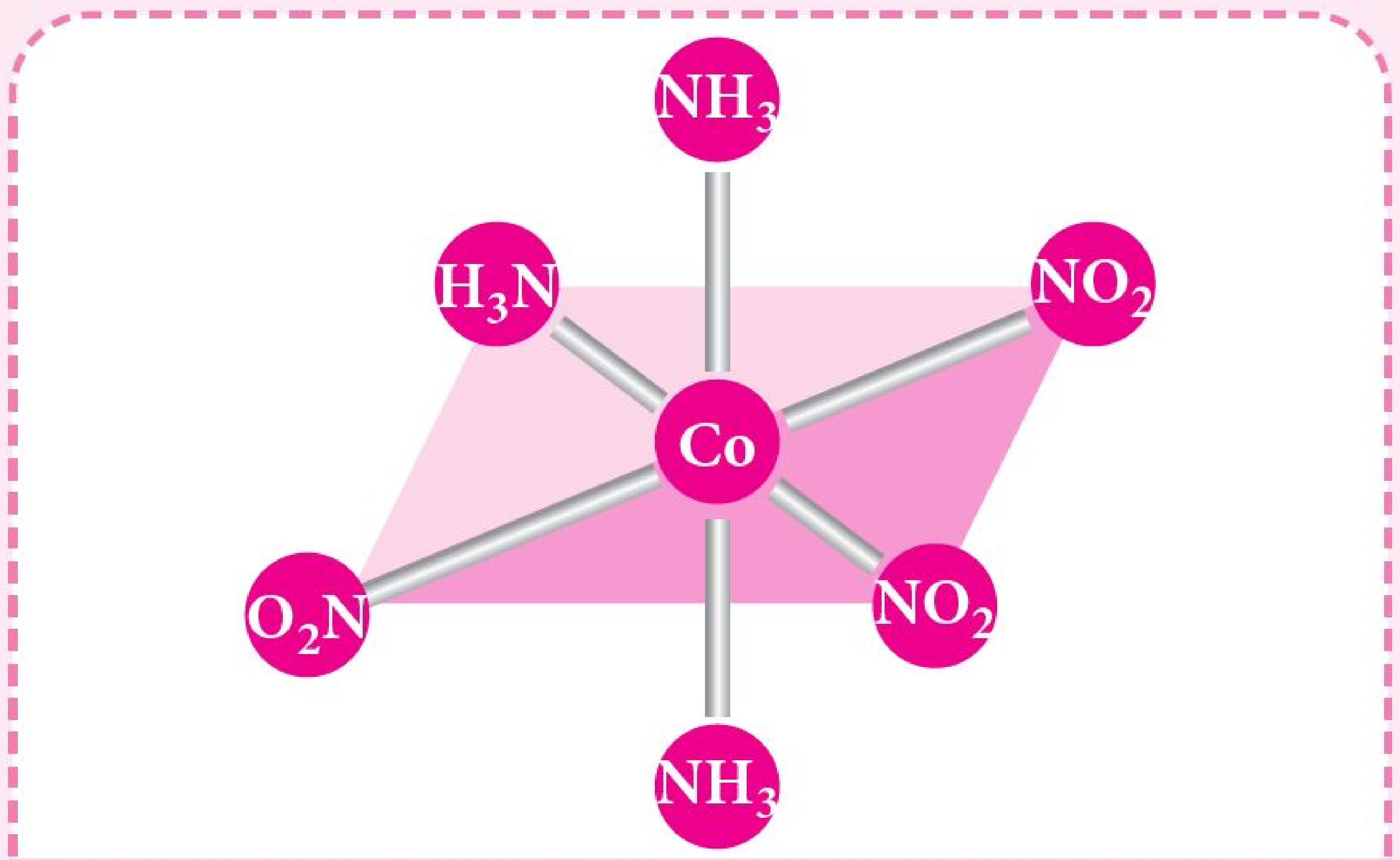
Geometrical Isomerism in Square Planar Complexes

Type	Example	
	***Cis*-Isomer**	***Trans*-Isomer**
MA_2B_2	 H_3N NH_3 Pt Cl Cl	 H_3N Cl Pt Cl NH_3
MA_2BC	 H_3N NH_3 Pt Cl Br	 H_3N Br Pt Cl NH_3
$M(ab)_2$	 H_2N NH_2 H_2C CH_2 Pt O=C C=O O O	 O NH_2 O=C CH_2 Pt H_2C C=O H_2N O
$MABCD$	 H_3N Br Pt Cl py  Br NH_3 Pt Cl py	 Br py Pt Cl NH_3

Geometrical Isomerism in Octahedral Complexes

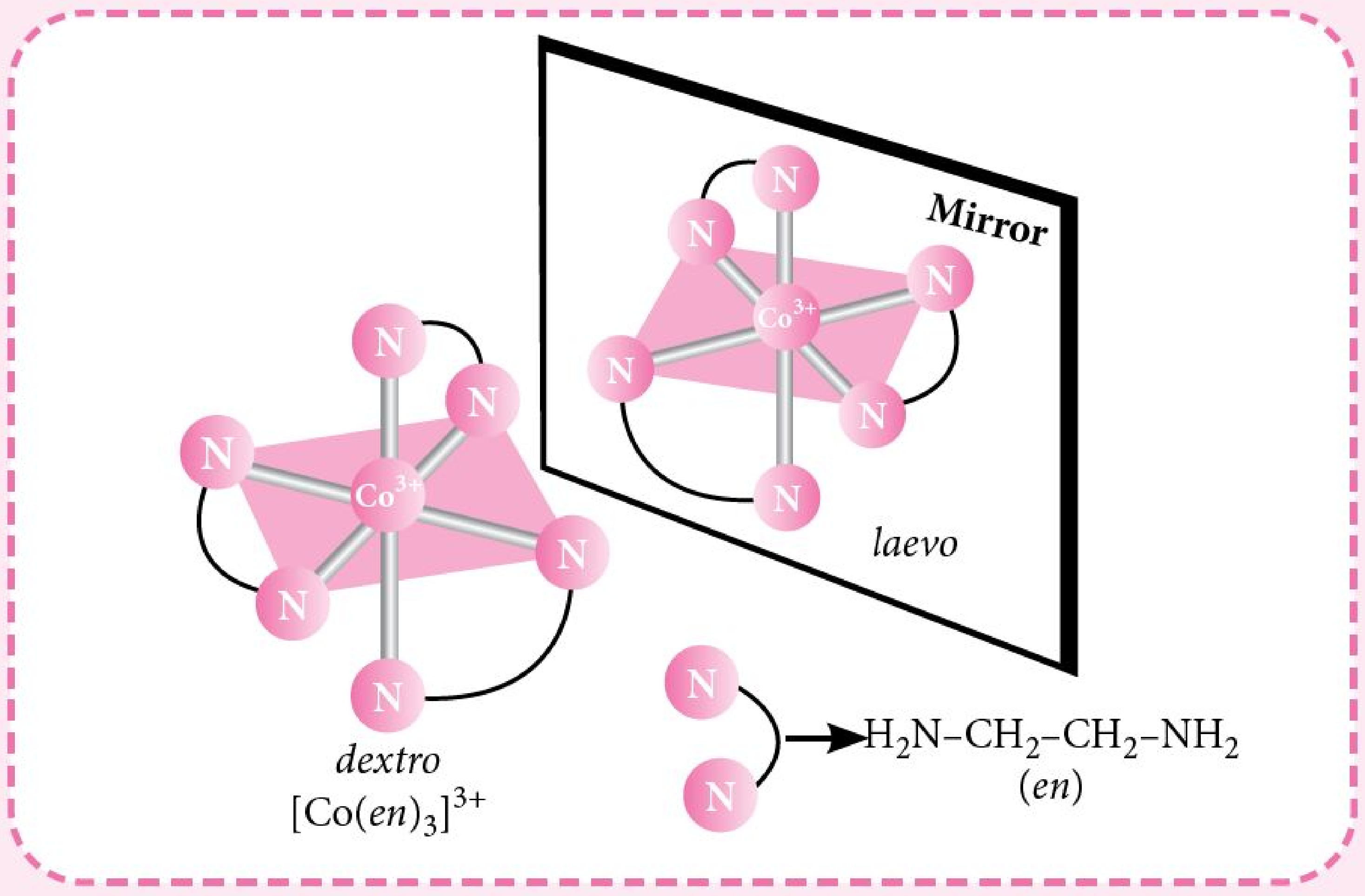

NH3
O2N
NH3
Co
O2N
NH3
NO2

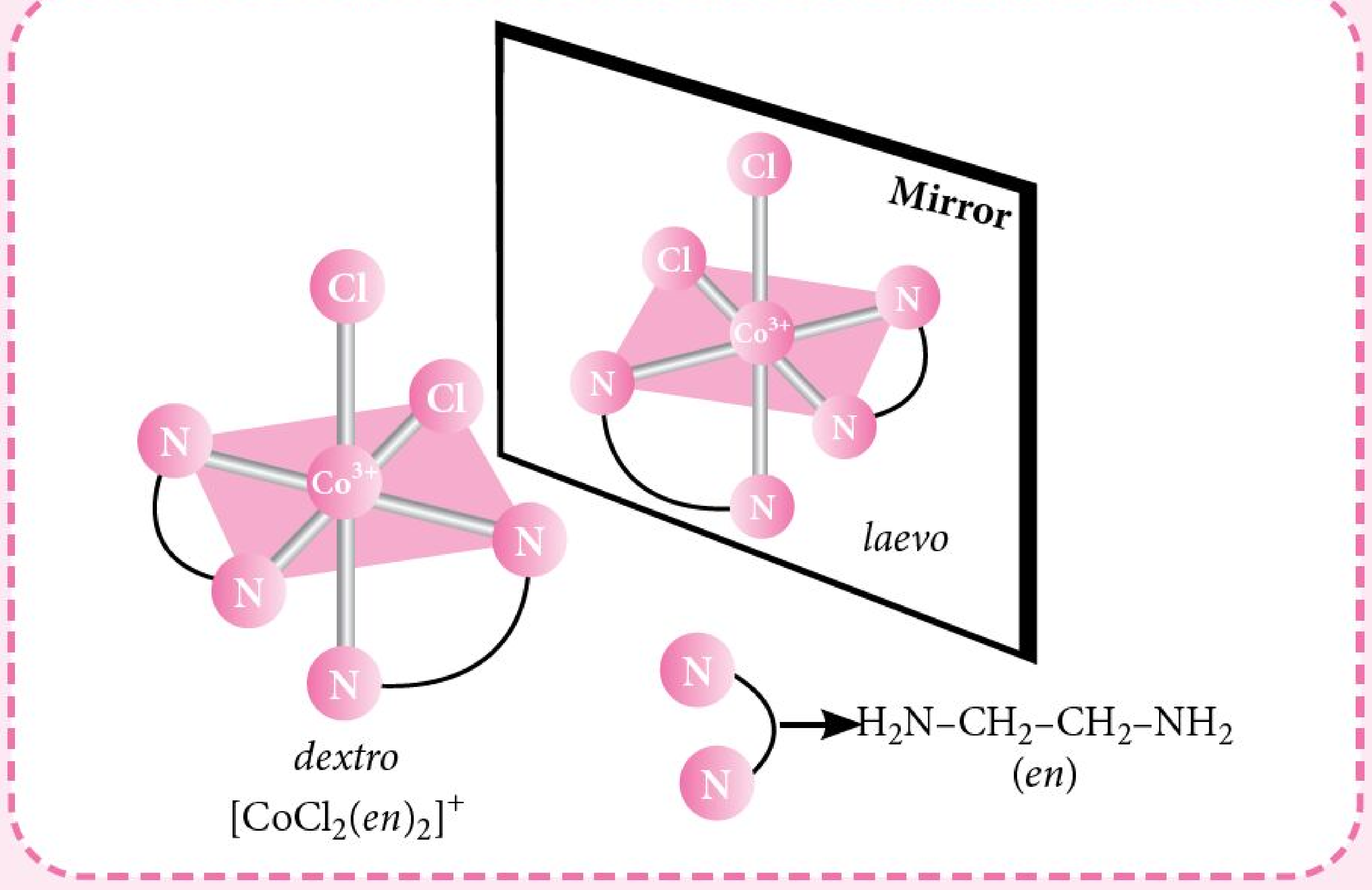
(a) Facial isomer


NH3
H3N
NO2
Co
O2N
NO2
NH3

(b) Meridional isomer

Optical Isomerism in Octahedral Complexes


Mirror
N
Co3+
laevo
dextro
[Co(en)3]3+
H2N–CH2–CH2–NH2
(en)


Mirror
Cl
N
Co3+
laevo
dextro
[CoCl2(en)2]+
H2N–CH2–CH2–NH2
(en)

Spectrochemical Series Of Ligands

$I^- < Br^- < S^{2-} < SCN^- < Cl^- < F^- < NO_3^- < \overset{-}{O}H <$ urea $<$ EtOH

Weak field ligand

$< C_2O_4^{2-}$ (Ox) $< O^{2-} < H_2O < NCS^- < EDTA^{4-} < NH_3$

Border line field ligands

pyridine < ethylenediammine (*en*) < dipyridyl (dipy) < phen $< NO_2^- < CN^- <$ CO

Strong field ligands

$CFSE_{(octahedral)} = [-0.4n_{(t_{2g})} + 0.6n_{(e_g)}]\,\Delta_o$

Relation between CFSE of octahedral and tetrahedral field.

$$\Delta_t \approx \frac{4}{9}\Delta_0$$

Metallurgy

Summary of Extraction of Metals

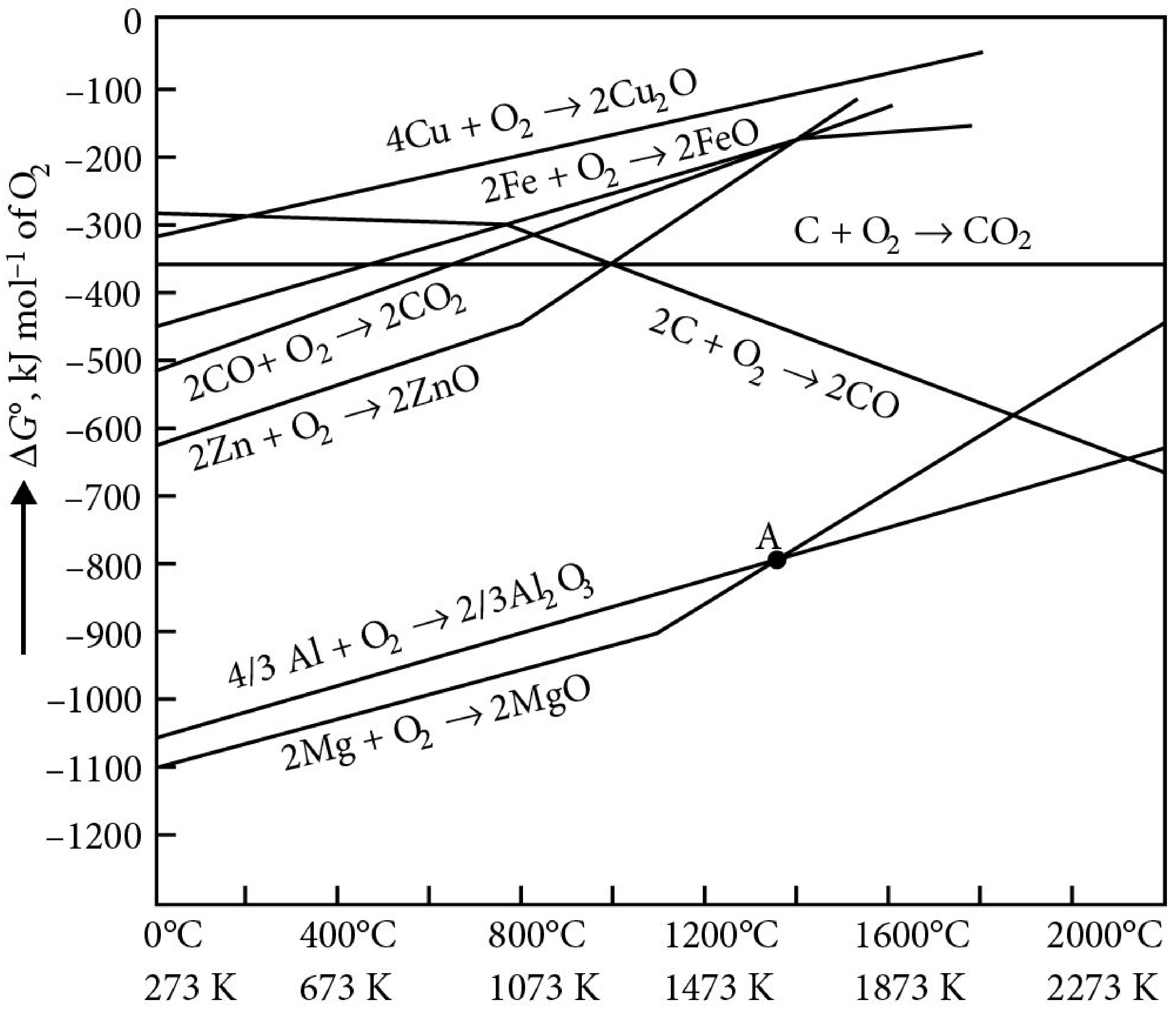
Metal	Main Occurrence	Main Method of Extraction
Magnesium	Carnallite, $KCl \cdot MgCl_2 \cdot 6H_2O$	Electrolysis of fused $MgCl_2$ with KCl
Aluminium	Bauxite, $Al_2O_3 \cdot 2H_2O$	Electrolysis of Al_2O_3 in molten Na_3AlF_6 (cryolite)
Iron	Haematite, Fe_2O_3 Magnetite, Fe_3O_4	Reduction of oxide with carbon monoxide $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$
Copper	Copper pyrites, $CuFeS_2$ Cuprite, Cu_2O	Partial oxidation of sulphide ore and auto-reduction $2Cu_2O + Cu_2S \longrightarrow 6Cu + SO_2$
Tin	Cassiterite, SnO_2	Reduction of SnO_2 with carbon, $SnO_2 + 2C \longrightarrow Sn + 2CO$

Lead	Galena, PbS	Reduction of PbO with carbon, $PbO + C \longrightarrow Pb + CO$
Silver	Argentite, Ag_2S Native silver	Leaching, $Ag_2S + 4NaCN \longrightarrow 2Na[Ag(CN)_2] + Na_2S$ $2Na[Ag(CN)_2] + Zn \longrightarrow Na_2[Zn(CN)_4] + 2Ag$

Ellingham Diagram

The plots between ΔG_f° of oxides of elements *vs.* temperature are called Ellingham diagrams.

- It provides a sound idea about selecting a reducing agent for reduction of oxides.
- Such diagrams help in predicting the feasibility of thermal reduction of an ore. ΔG must be –ve at a given temperature for a reaction to be feasible.



Gibbs energy (ΔG°) *vs* *T* plots (schematic) for formation of some oxides (Ellingham diagram)

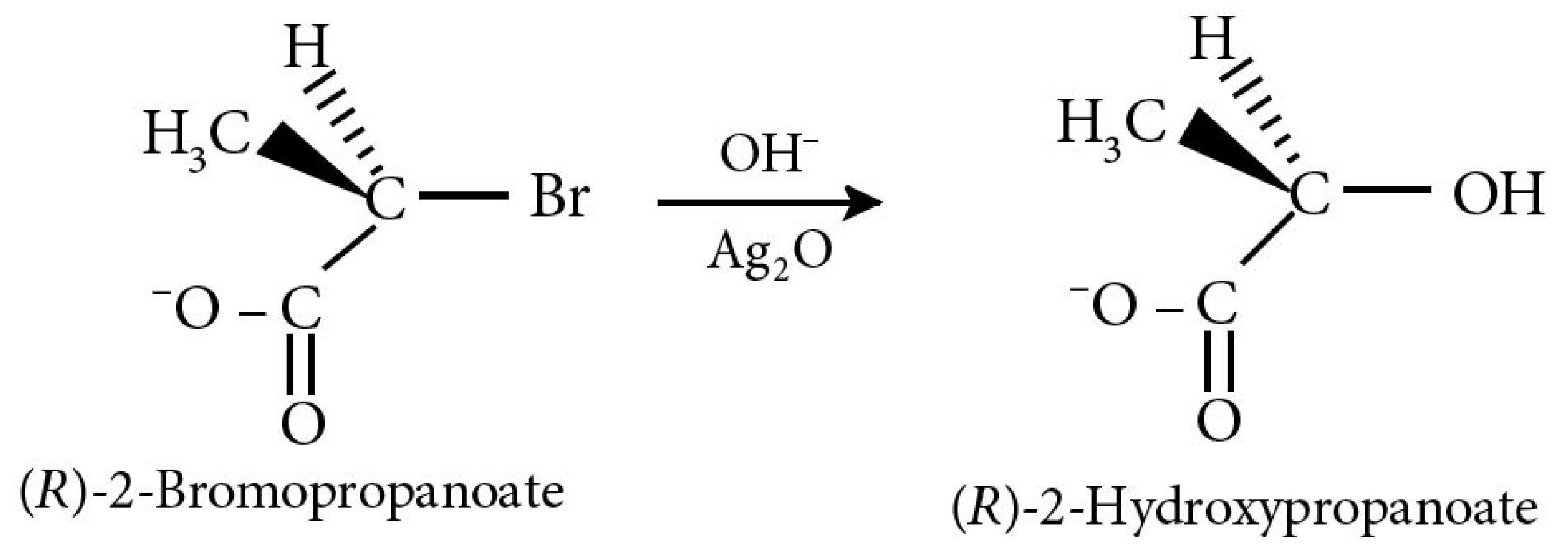
ORGANIC CHEMISTRY

Comparison of S_N1 and S_N2 Reaction Mechanism

Factor	S_N1	S_N2
Kinetics	Rate = $K[RX]$	Rate = $K[RX]\,[Nu^-]$
Primary alkyl substrate	Never unless additional stabilising groups present	Good unless hindered.
Secondary alkyl substrate	Moderate	Moderate
Tertiary alkyl substrate	Excellent	Never
Leaving group	Important	Important
Nucleophilicity	Unimportant	Important
Preferred solvent	Polar protic	Polar aprotic
Stereochemistry	Racemisation (+ partial inversion possible)	Inversion
Rearrangements	Common	Rare
Eliminations	Common, especially with basic nucleophiles	Only with heat and basic nucleophiles.
Catalysis	Ag^+, $AlCl_3$	Polar aprotic solvents, Phase transfer.

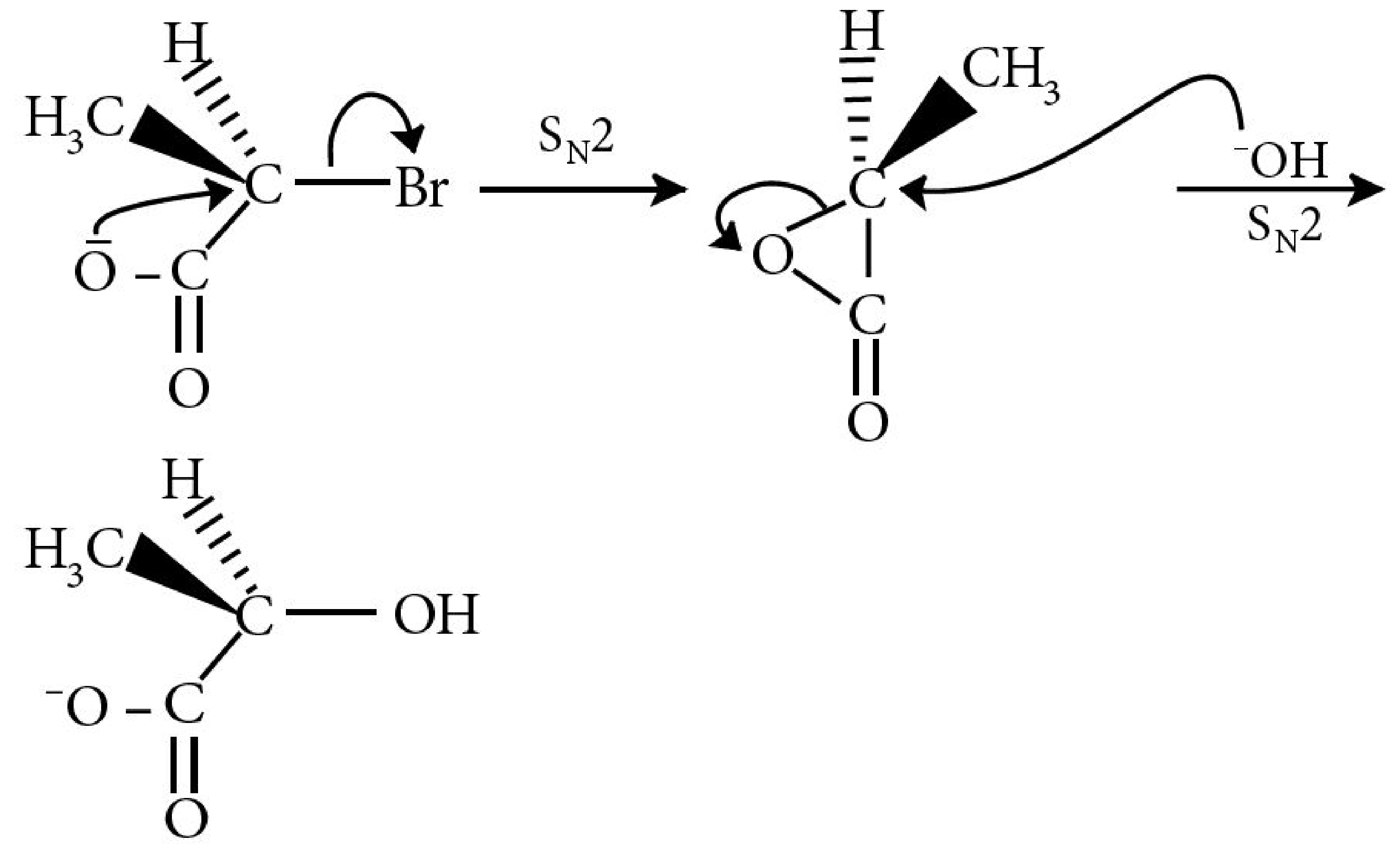
Neighbouring Group Participation (NGP)

Here is an amazing experimental fact, (*R*)–2–bromopropanoate when treated with low concentration of hydroxide ion in presence of Ag_2O gives (*R*)–2–hydroxypropanoate.


H
H_3C
C — Br
^-O-C
O
OH^-
Ag_2O
H
H_3C
C — OH
^-O-C
O

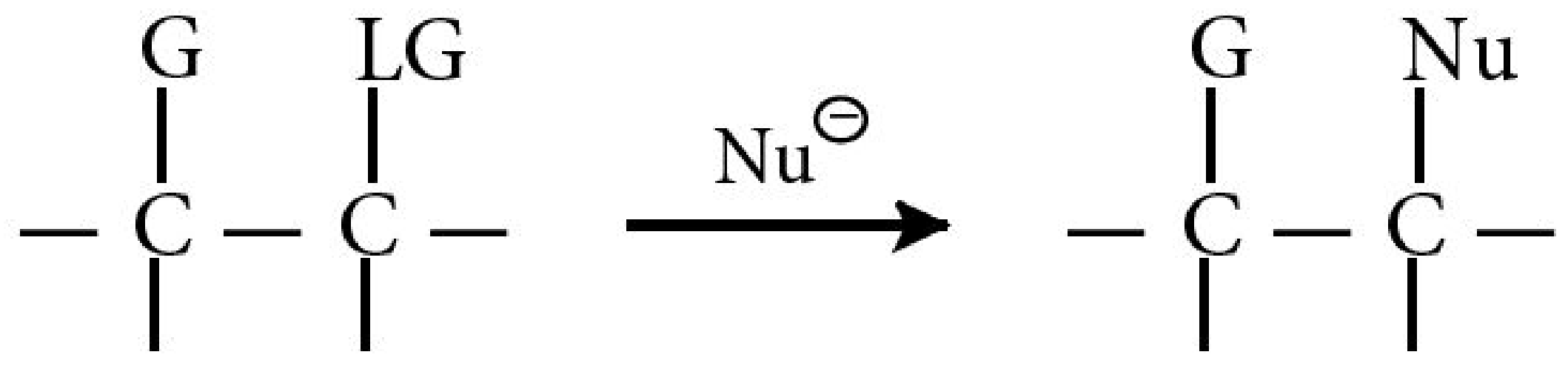
(*R*)-2-Bromopropanoate (*R*)-2-Hydroxypropanoate

Clearly the reaction is a nucleophilic substitution, Br^- being replaced by OH^-. Had it been a S_N2 reaction inversion would have been the result. Similarly, if it were a S_N1 reaction, racemisation would have taken place. The retention of configuration is neither consistent with S_N1 nor with S_N2 mechanism. The stereochemical result so obtained implies something different might be taking place other than simple S_N1 or S_N2.

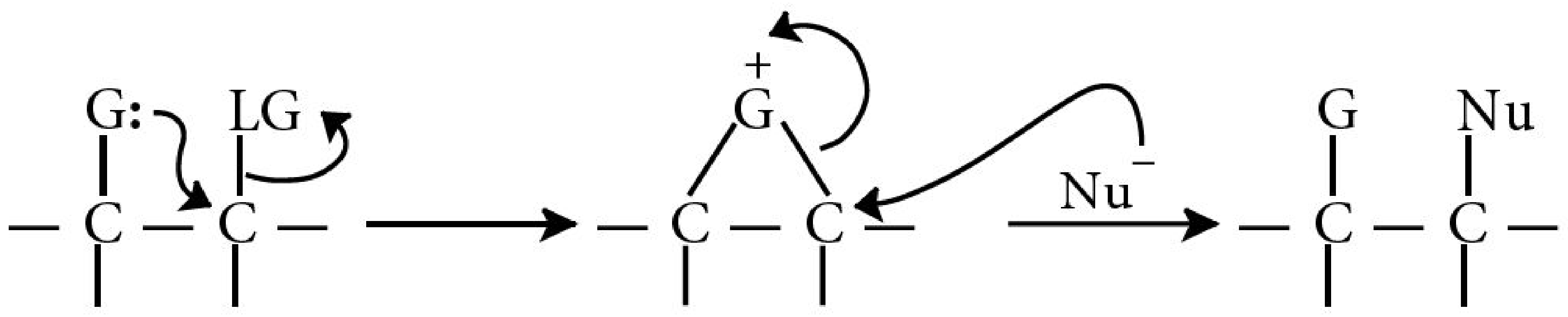

H
H_3C
C — Br
$\bar{O}-C$
O
S_N2
H
CH_3
C
O
C
O
^-OH
S_N2
H
H_3C
C — OH
^-O-C
O

The reaction is thus a combination of two S_N2 reactions.

Double inversion is retention. What we are watching is :


G
LG
— C — C —
$Nu^\ominus$
G
Nu
— C — C —

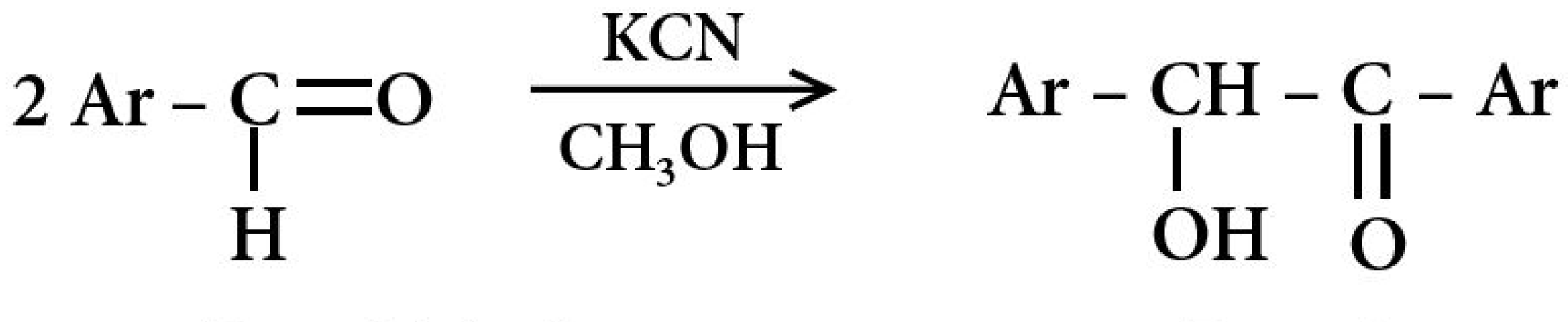
But what actually takes place is :


G:
LG
— C — C —
$\overset{+}{G}$
— C — C —
Nu^-
G
Nu
— C — C —

Such involvement of a group within the same molecule is known as neighbouring group participation (NGP). The rate enhancement due to NGP is called **anchimeric assistance.**

Benzoin Condensation

Benzaldehyde and other non-enolisable aldehydes undergo condensation when refluxed with methanolic KCN to give benzoin. This reaction is called benzoin condensation.



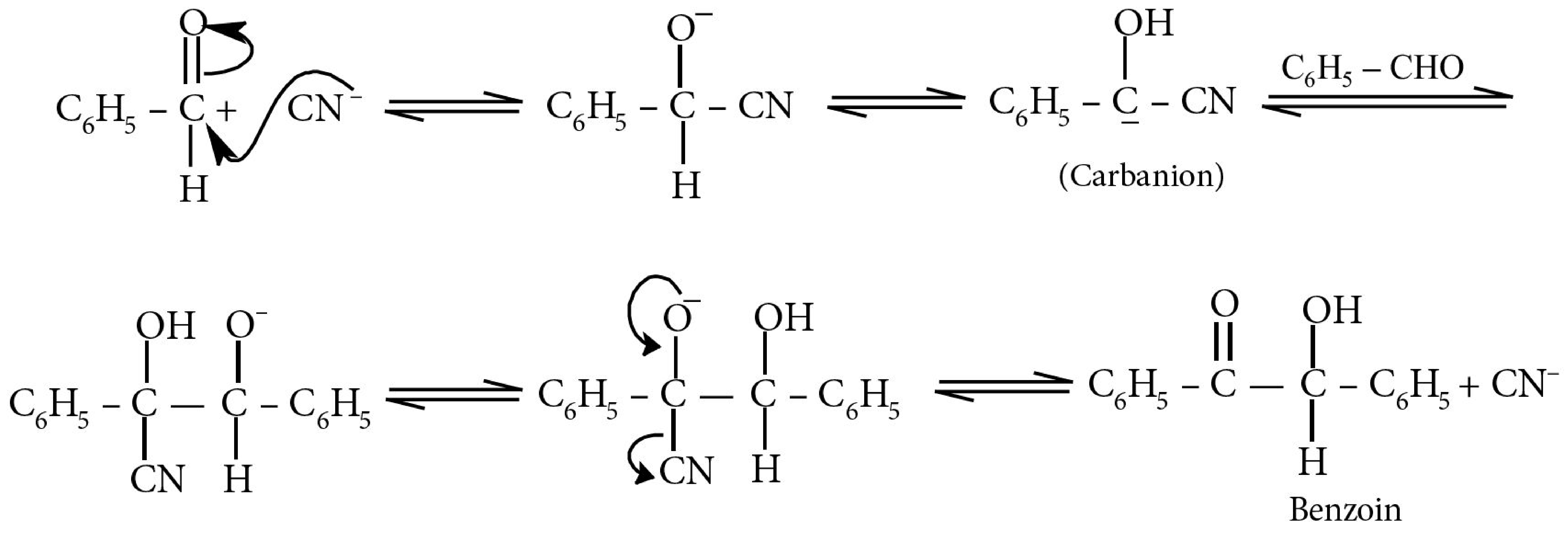
$$2\,Ar-\underset{H}{C}=O \xrightarrow[CH_3OH]{KCN} Ar-\underset{OH}{CH}-\underset{O}{\overset{\|}{C}}-Ar$$

Benzaldehyde **Benzoin**

Aliphatic aldehydes fail to give this reaction.

Mechanism

The cyanide ion attacks one molecule of benzaldehyde. The aldehydic hydrogen now becomes sufficiently acidic to form a resonance stabilised carbanion, which then attacks the second molecule of aldehyde. The reaction is reversible.

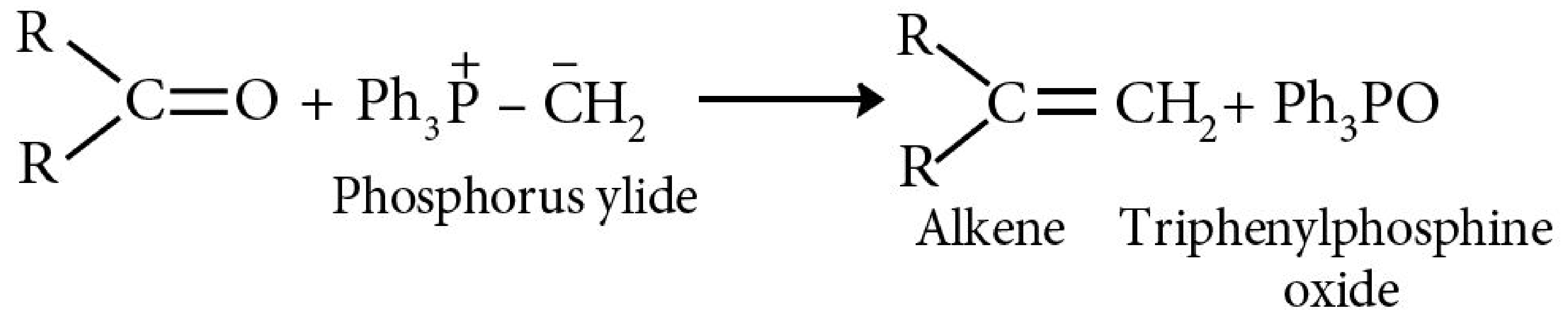

O
C_6H_5-C+
H
CN^-
O^-
C_6H_5-C-CN
H
OH
$C_6H_5-\underline{C}-CN$
(Carbanion)
C_6H_5-CHO
OH O^-
$C_6H_5-C-C-C_6H_5$
CN H
O^- OH
$C_6H_5-C-C-C_6H_5$
CN H
O OH
$C_6H_5-C-C-C_6H_5+CN^-$
H
Benzoin

Benzoin condensation is a bimolecular reaction.

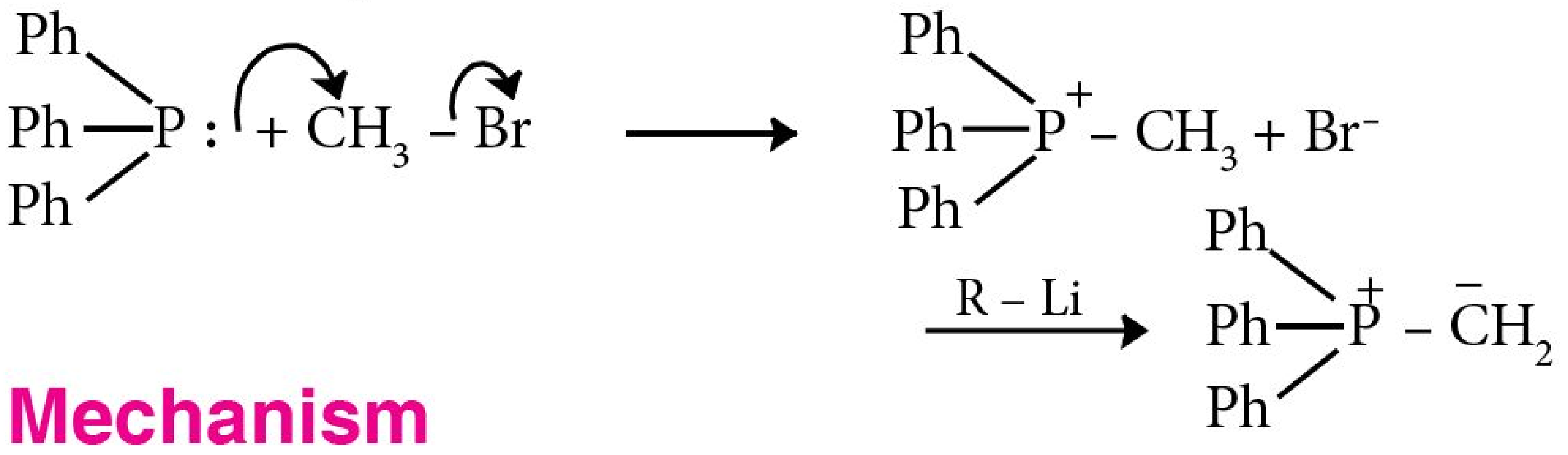
We know a number of other nucleophiles such as EtO^-, $^-SO_3$ Na can also attack benzaldehyde but it is the CN^- which can specifically catalyse the benzoin condensation.

Wittig Reaction

In Wittig reaction, phosphorus ylides react with aldehydes and ketones to introduce a C=C double bond selectively in place of the carbonyl group. The reaction has been named after George Wittig, who shared 1979 Noble prize for his work on this reaction.

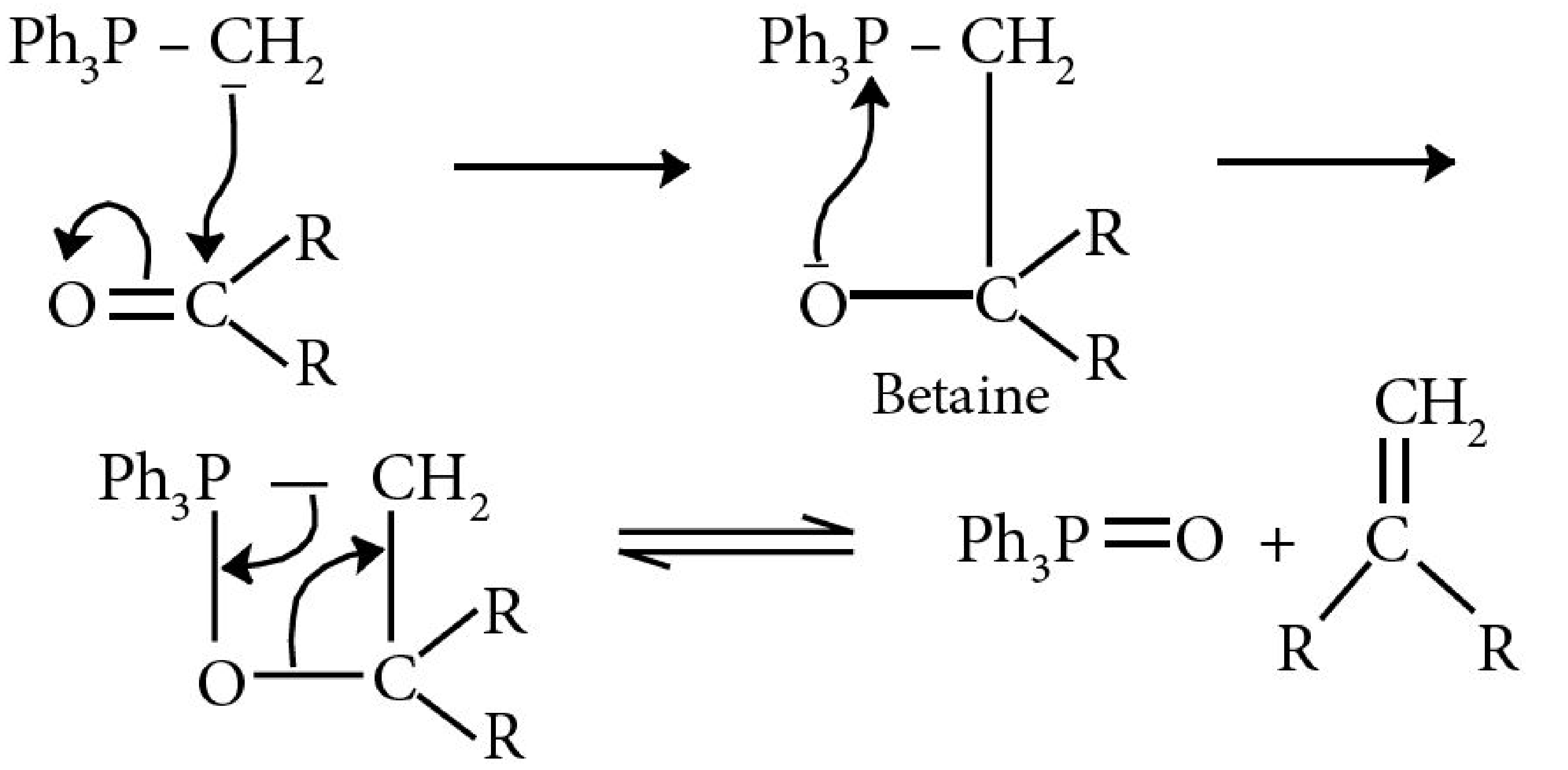


Phosphorus ylide or phosphorane used in this reaction is prepared by treatment of phosphonium salt with a base. Phosphorus ylides are neutral molecules having positive and negative centres on adjacent atoms connected by a σ-bond.



Mechanism

Phosphorus ylides are strongly polar molecules with carbanion character. They react enthusiastically with aldehyde and ketone to give an intermediate. The ring closure of this intermediate, followed by ring opening yields the alkene.

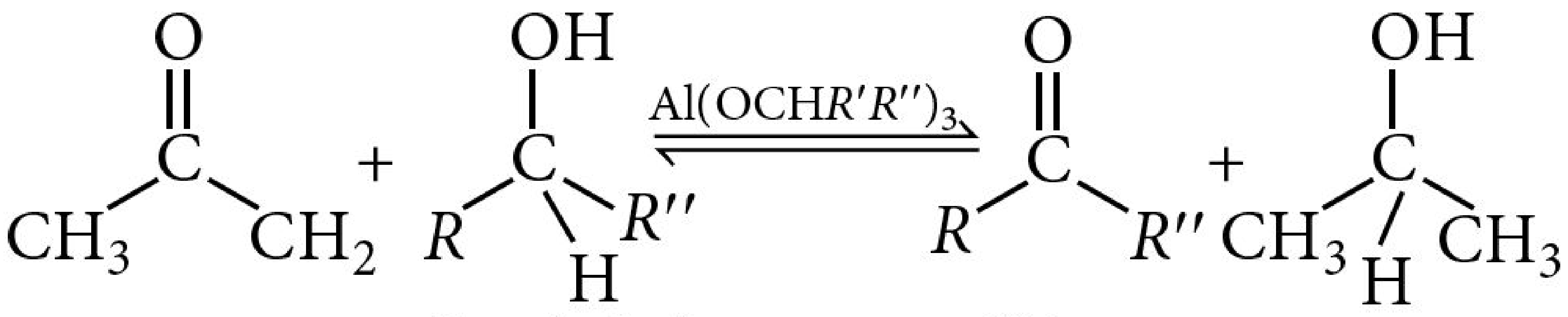


Oxaphosphetane

(Alkene)

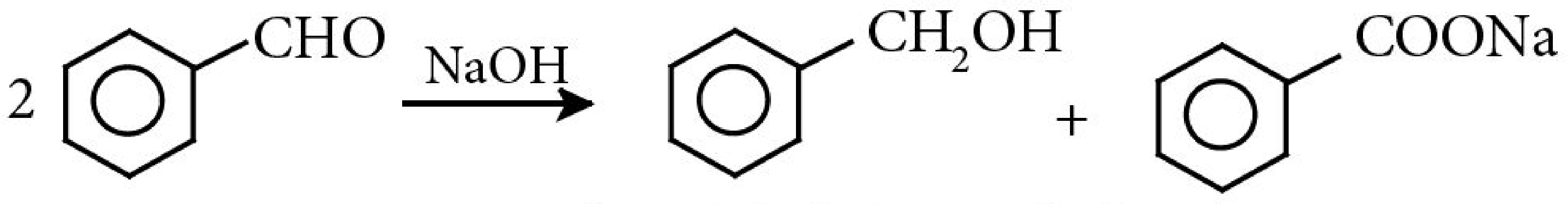
Oppenauer Oxidation

The gentle method of converting secondary alcohols to ketones using aluminium alkoxide is known as Oppenauer oxidation, named after Rupert Victor Oppenauer.

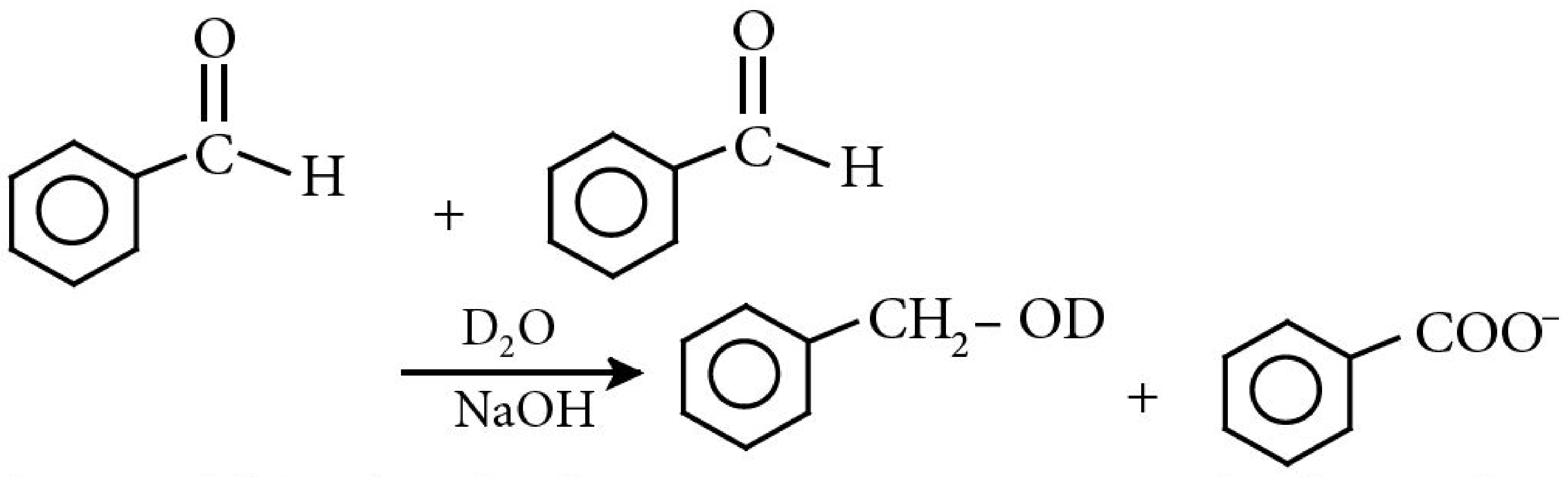


Cannizzaro Reaction

Non-enolisable aldehydes or aldehydes without α-hydrogen atoms undergo disproportionation in presence of strong base. This is called Cannizzaro reaction.

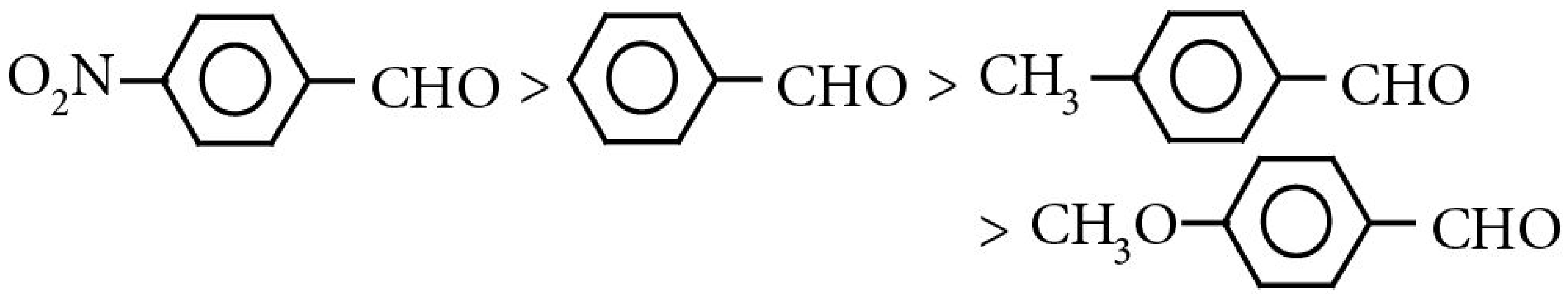


Which hydrogen really goes where can be understood from the following reaction.

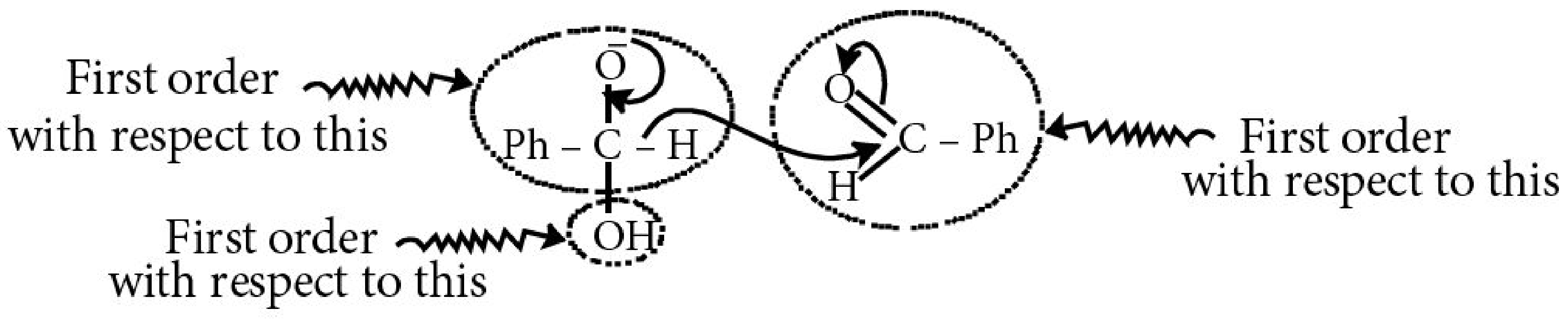


Two aldehydic hydrogens are now attached to the carbon atom carrying the —OH group. Note that the product does not have any C—D bond.

The order of reactivity of different aromatic aldehydes towards Cannizzaro reaction is:

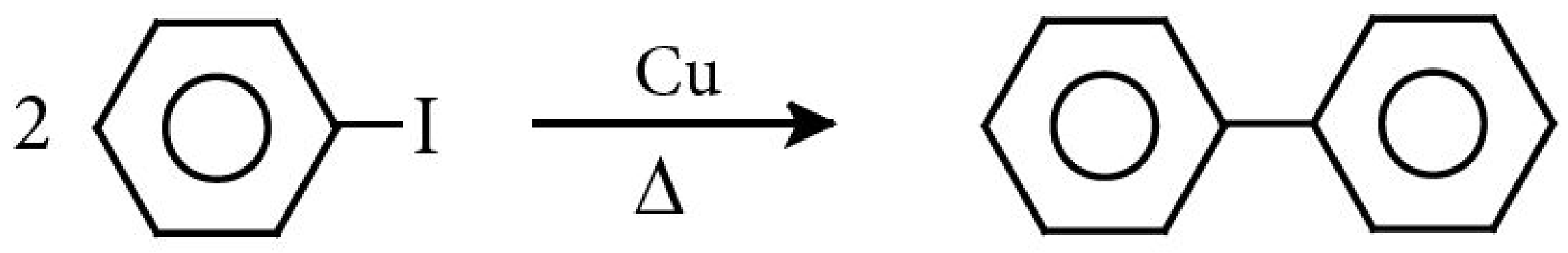


The reaction follows third order kinetics. This means the hydride transfer is the slow and the rate determining step.


First order with respect to this
First order with respect to this
First order with respect to this

Ullmann Reaction

The coupling of aryl halides with copper is called Ullmann reaction, named after Fritz Ullmann.



The reaction is most often carried out on aryl iodide. The reactivity changes in the order.

I ~ Br > Cl >> F

The reaction is subjected to steric hindrance, if bulky groups are present on either side of the halogen atom.

Williamson's Ether Synthesis

Reactions of alkoxide ion with *pri*-alkyl halides, sulphate or sulphonate via S_N2 mechanism to give ethers is known as Williamson's ether synthesis, named after Alexander Williamson.

$$R-\bar{O}\overset{+}{Na} + R'-LG \longrightarrow \underset{\text{Ether}}{R-O-R'} + Na^{+}LG^{-}$$

$LG = -Cl, -Br, -I, -OSO_2R, -OSO_2OR$

Tertiary halides cannot be used to give ether. Even secondary halides are of little use in this reaction.

Mechanism

The reaction mechanism is simple S_N2. Alkoxide directly attacks the substrate displacing the leaving group in one 'go'.

$$R-\overset{-}{O}Na^{+} + R'-LG \longrightarrow R-O-R' + Na^{+}LG^{-}$$

Consider few examples. Let us start with the synthesis of a symmetrical ether.

$$CH_3-CH_3-ONa + CH_3-CH_2-I \rightarrow CH_3-CH_2-O-CH_2 + NaI$$

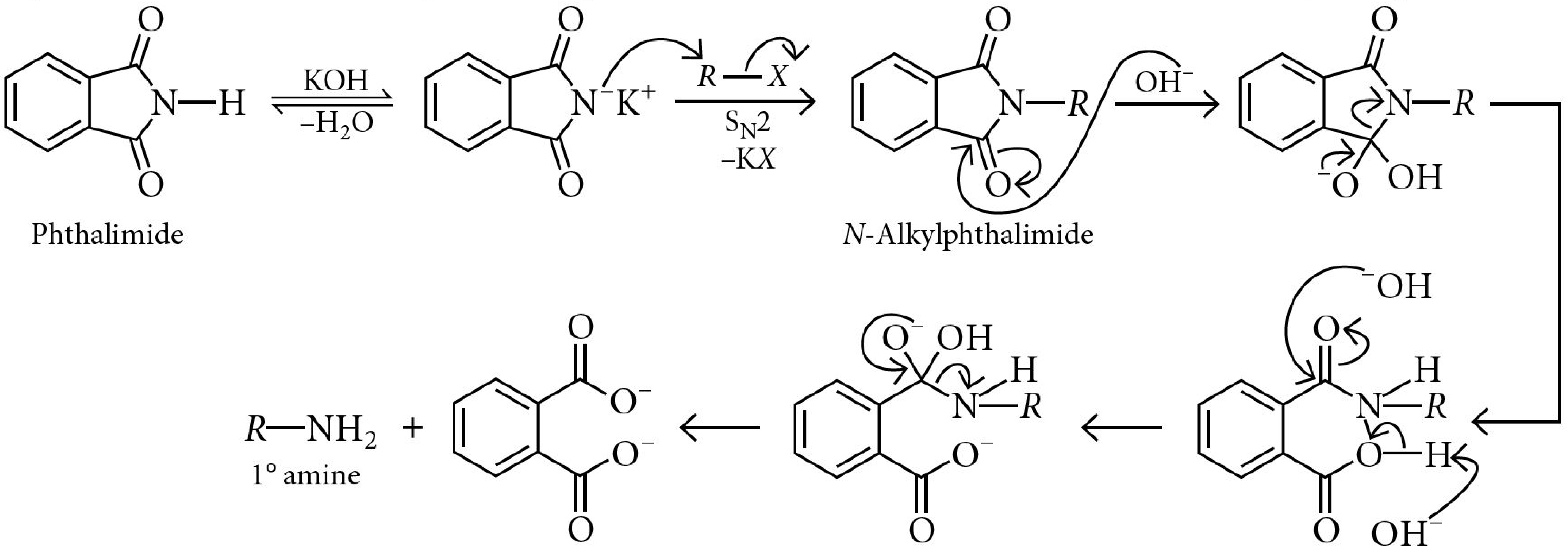
Diethyl ether

$$CH_3-CH_2-CH_2-CH_2-\overset{-}{O}\overset{+}{Na} + CH_3-CH_2-I \rightarrow CH_3-CH_2-CH_2-CH_2-O-CH_2-CH_3 + NaI$$

1-Ethoxybutane

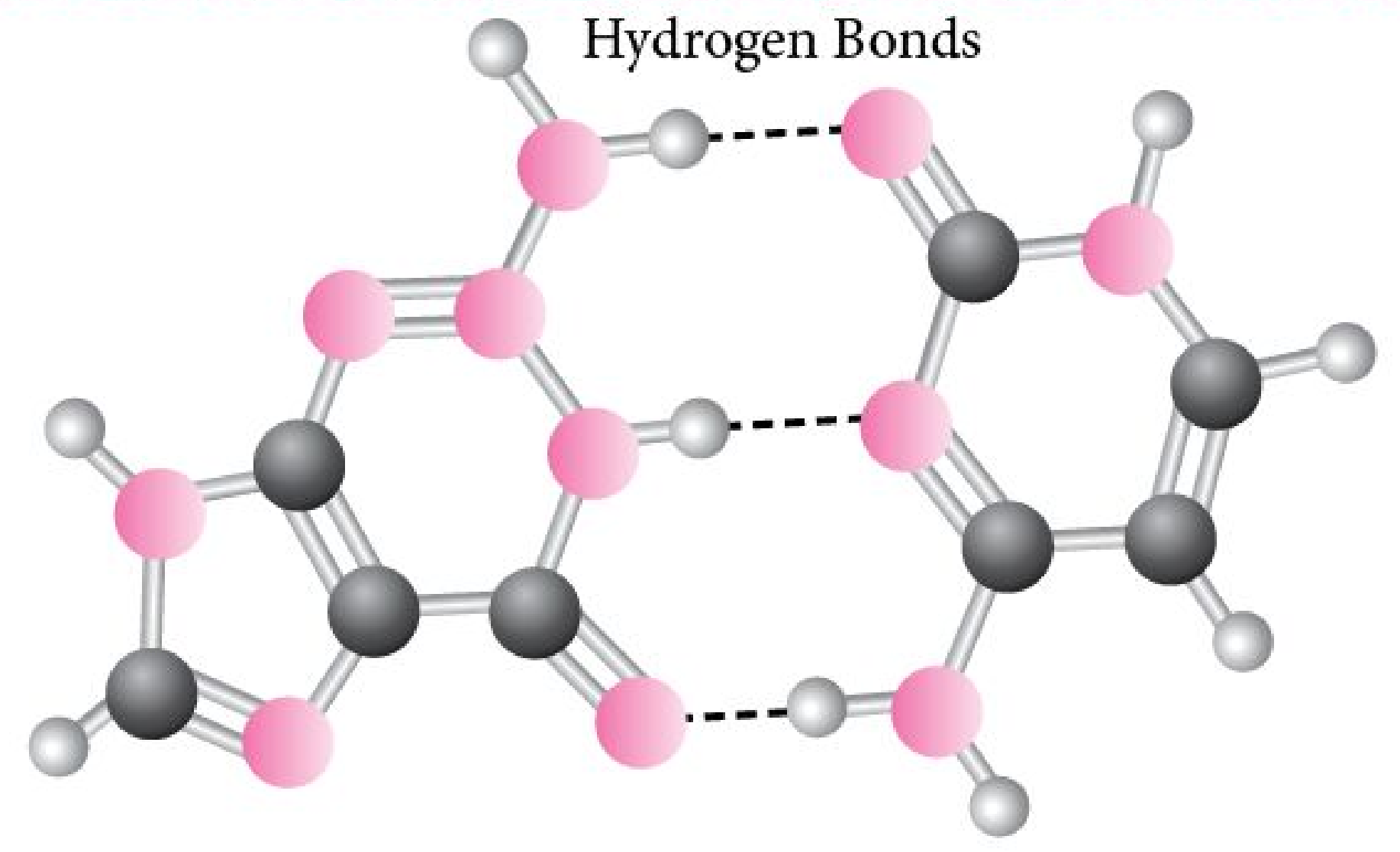
Gabriel Phthalimide Synthesis

It is used for the preparation of primary amines. Aromatic primary amines can not be prepared by this method because aryl halides do not undergo nucleophilic substitution with the anion formed by the phthalimide.

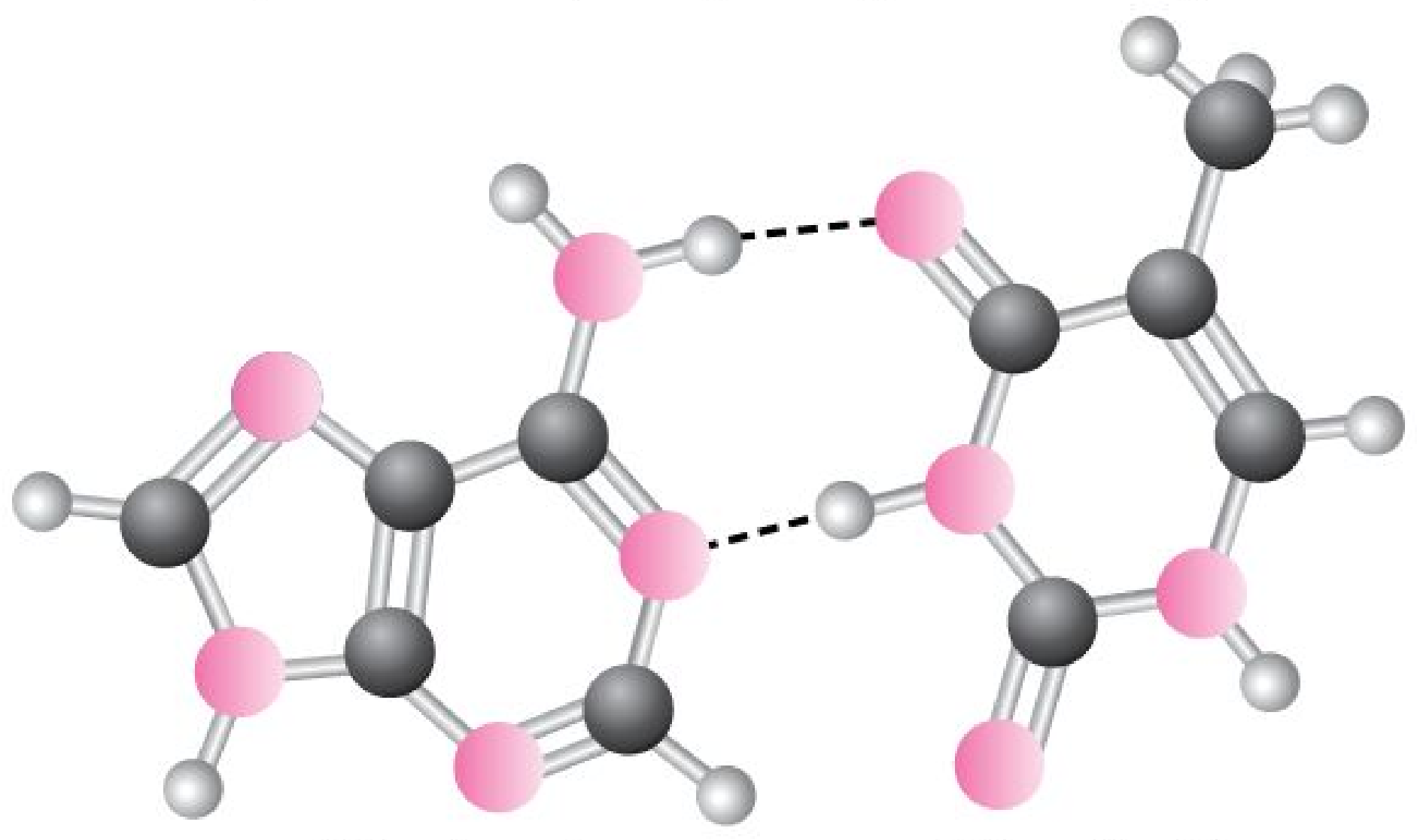


Biomolecules

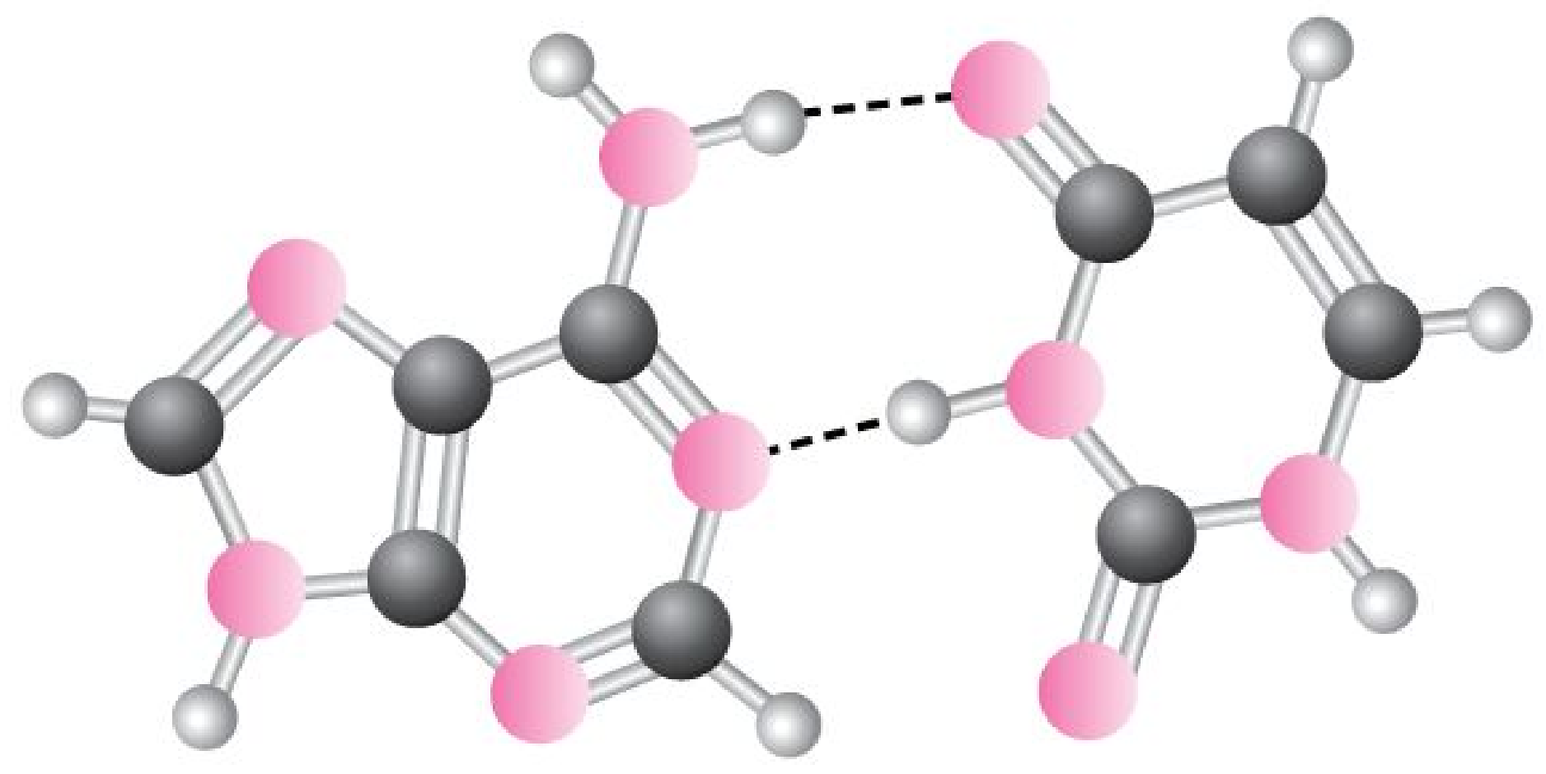
H-Bonding in Nitrogenous Bases (Chargaff's Rule)



Guanine G Cytosine C
(Bonded by 3 hydrogen bonds)

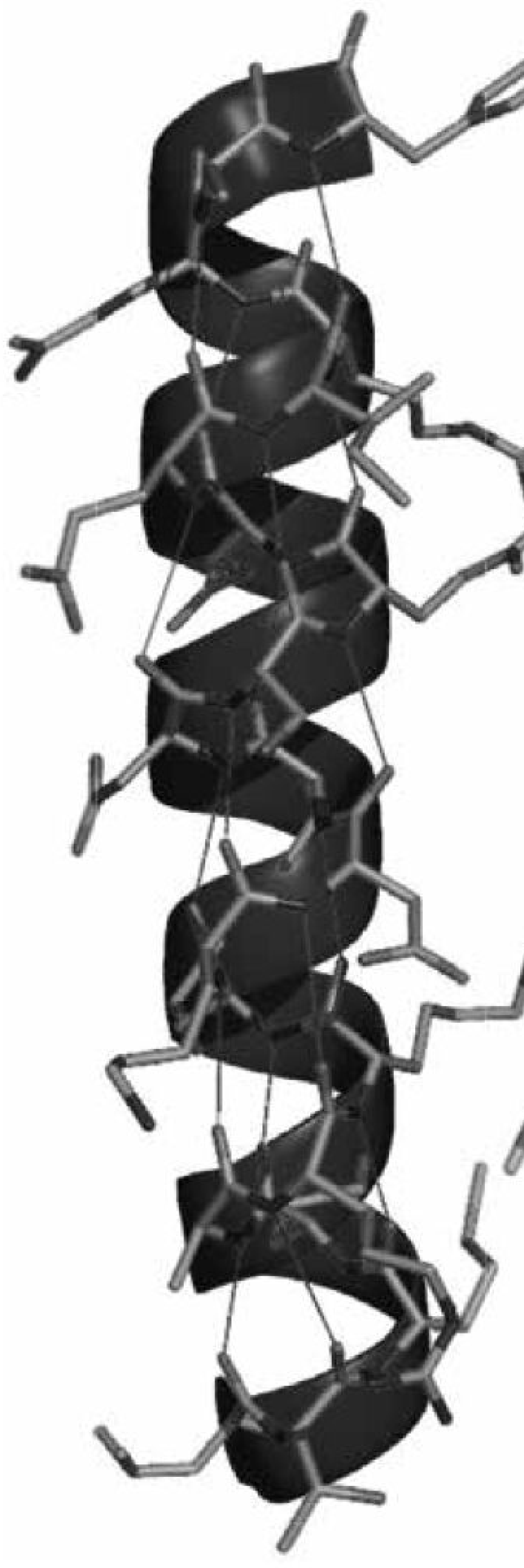


Adenine A ThymineT
(Bonded by 2 hydrogen bonds)

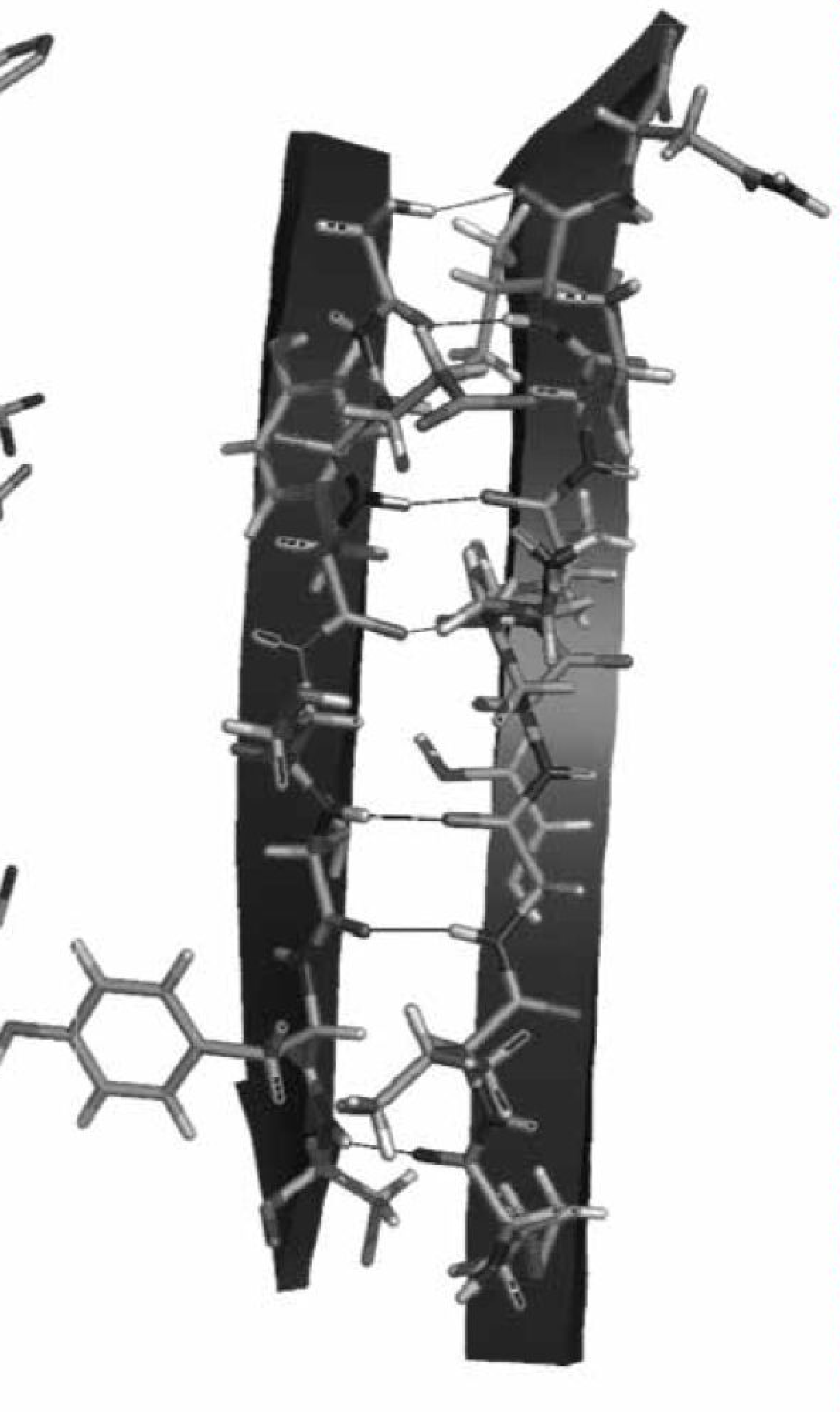


Adenine A Uracil U
(Bonded by 2 hydrogen bonds)

Structure of Protein



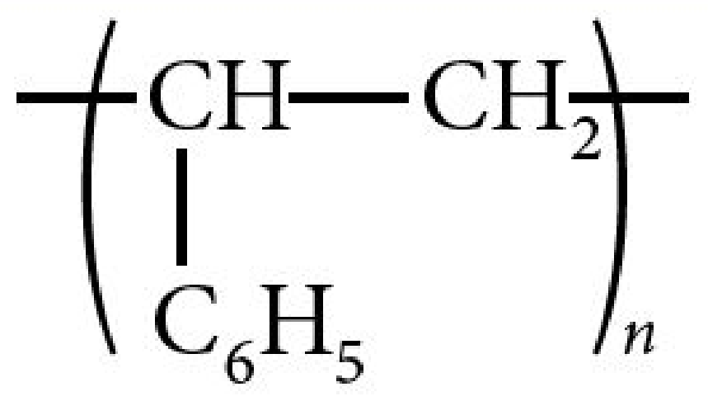
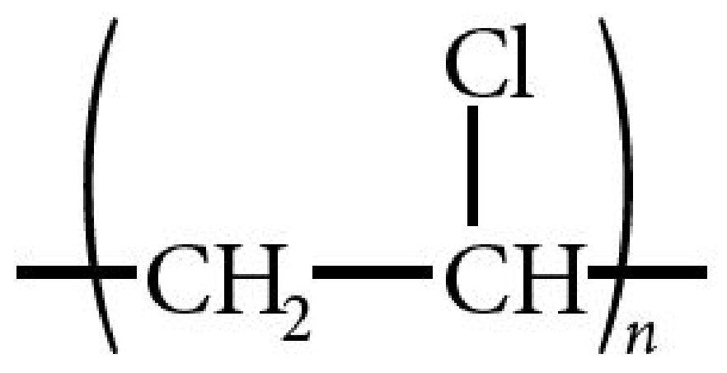
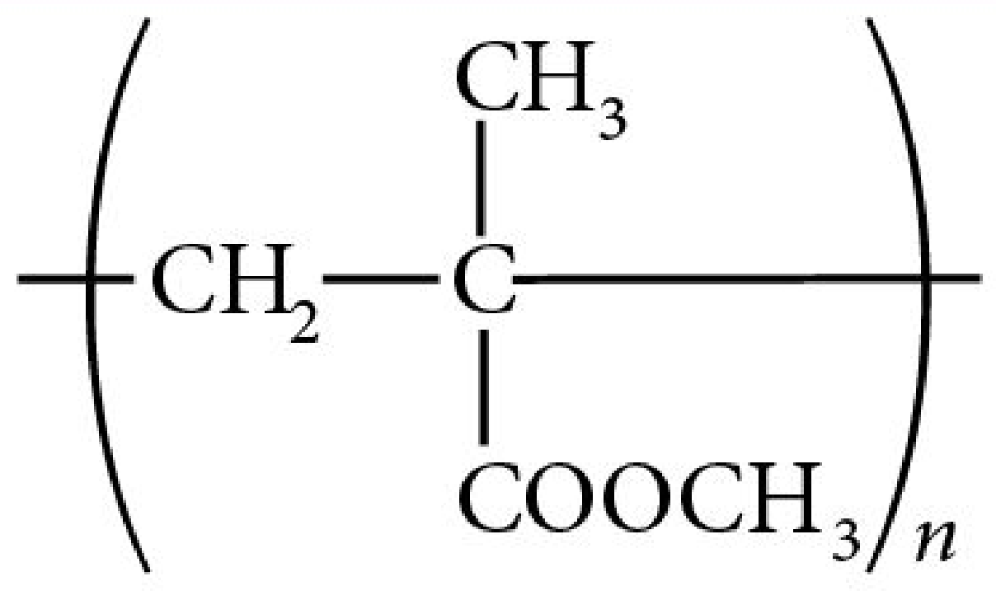
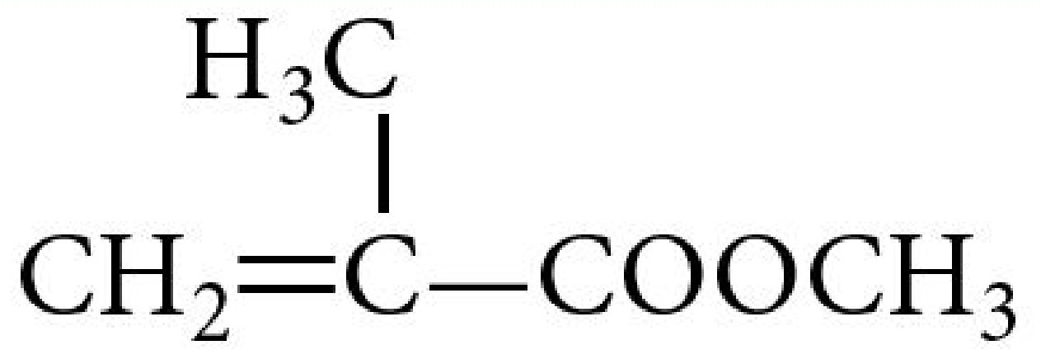
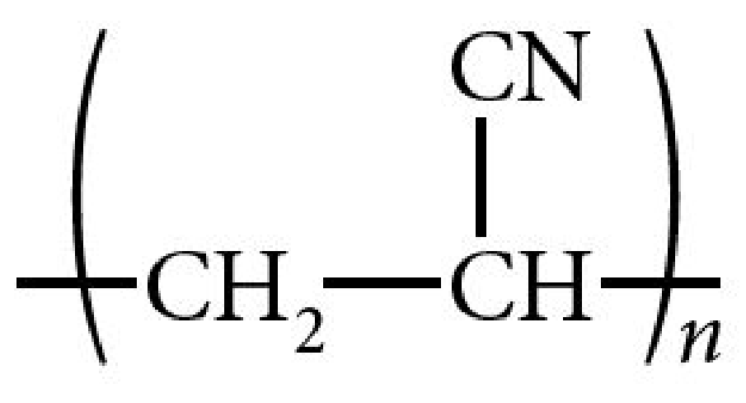
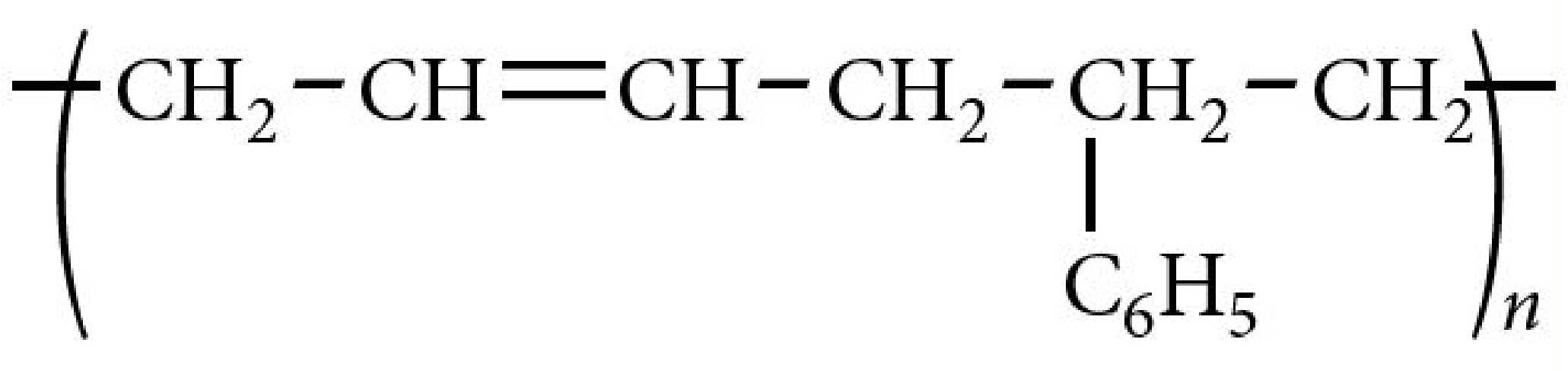
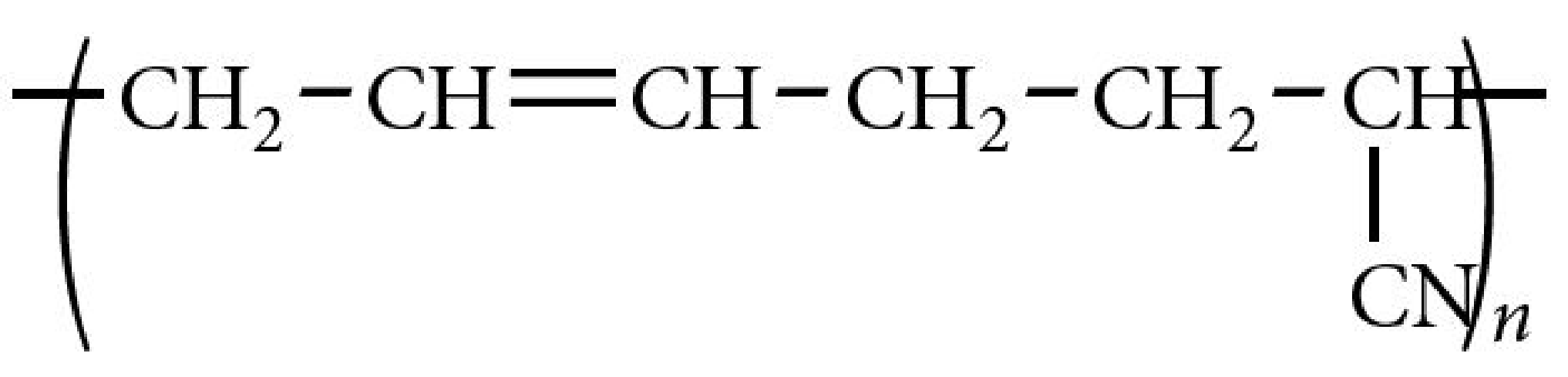
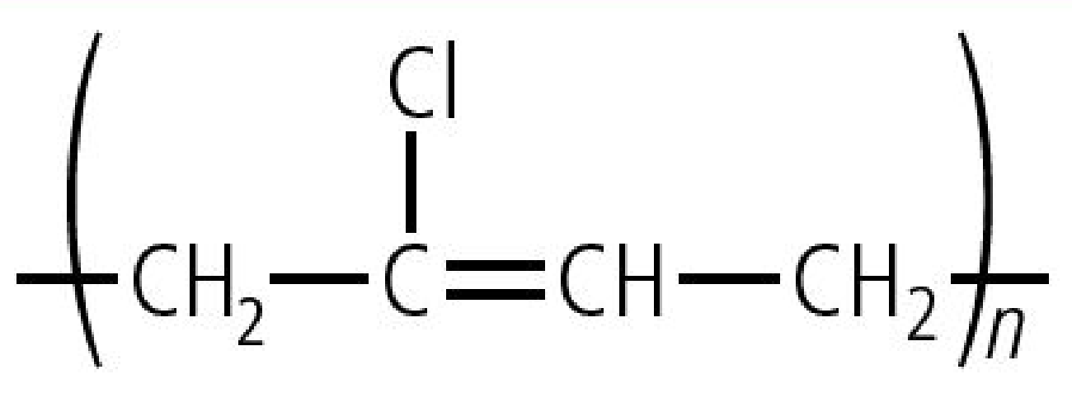
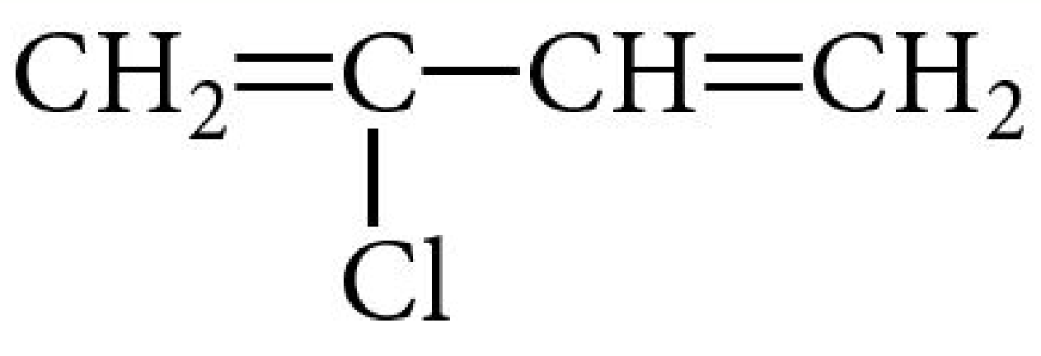
(a) α-helix structure
(Hydrogen bonds present in peptide chain twisted helically)

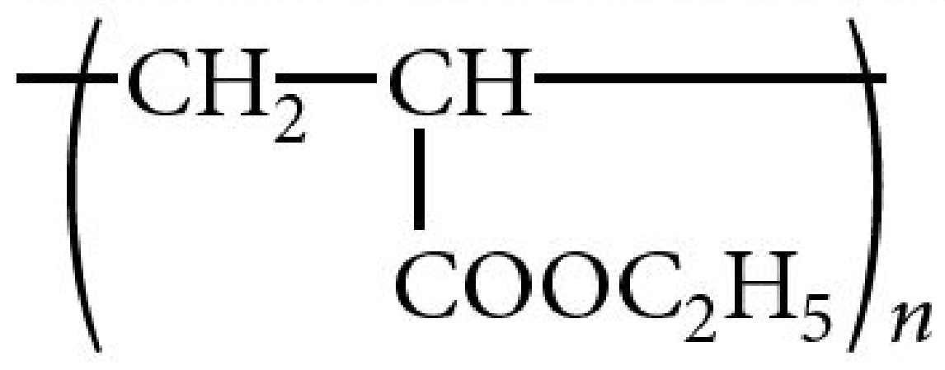
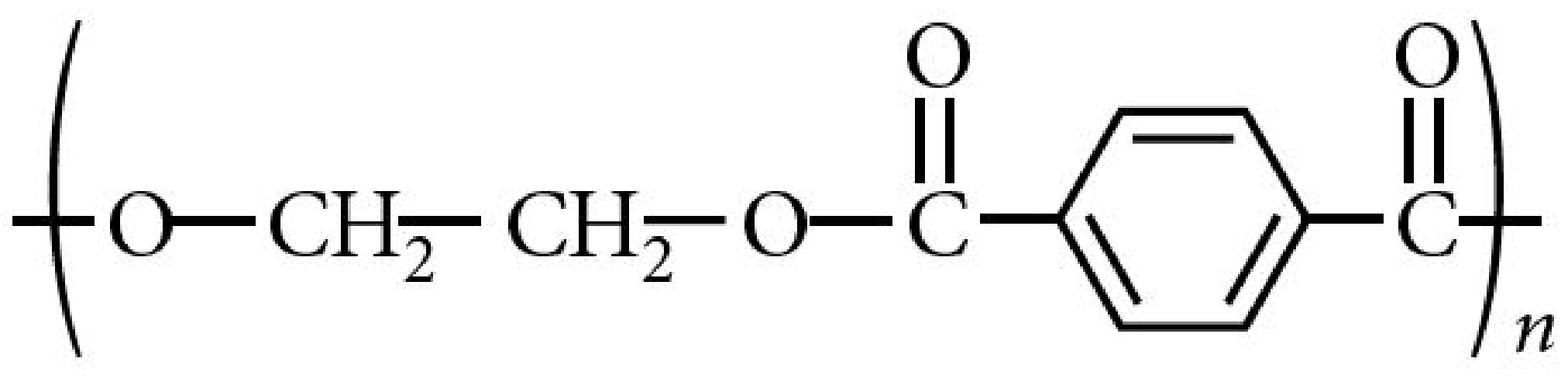
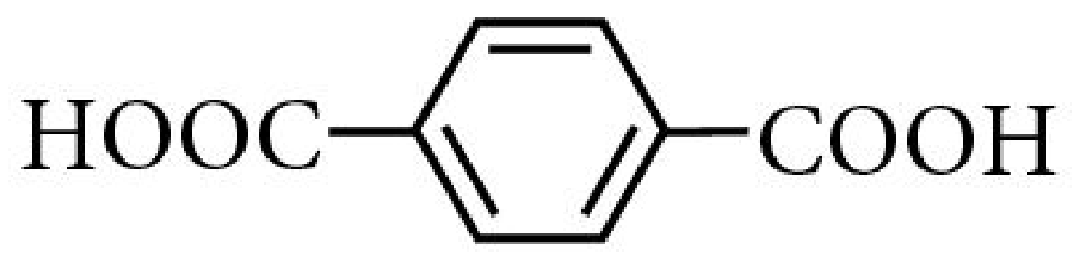
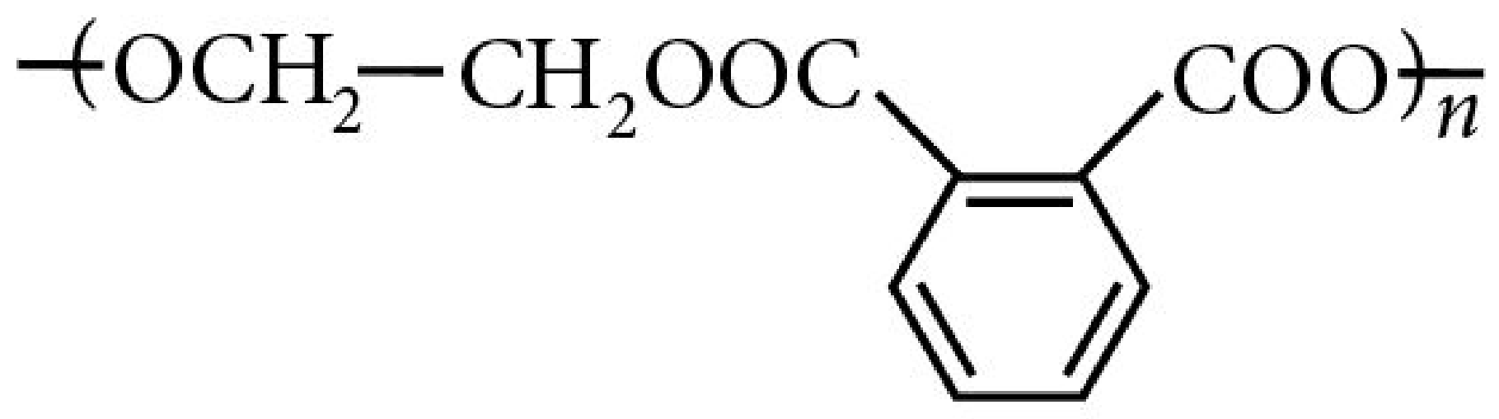
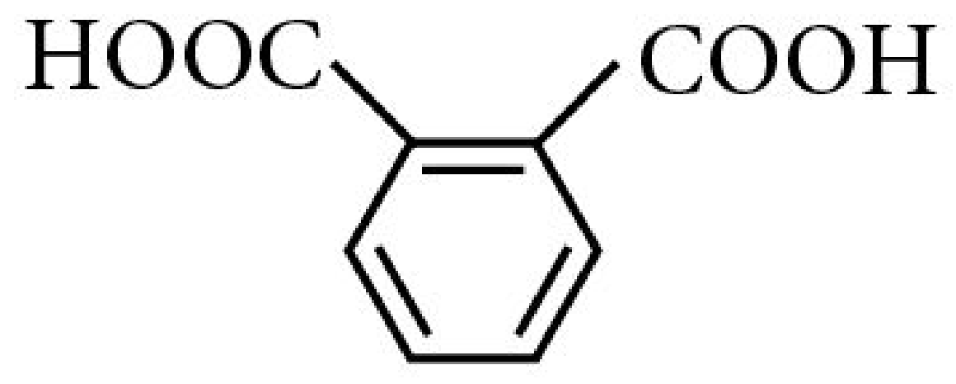
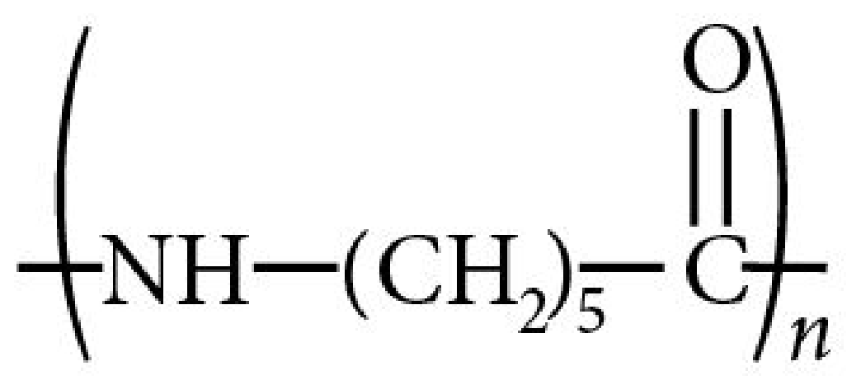
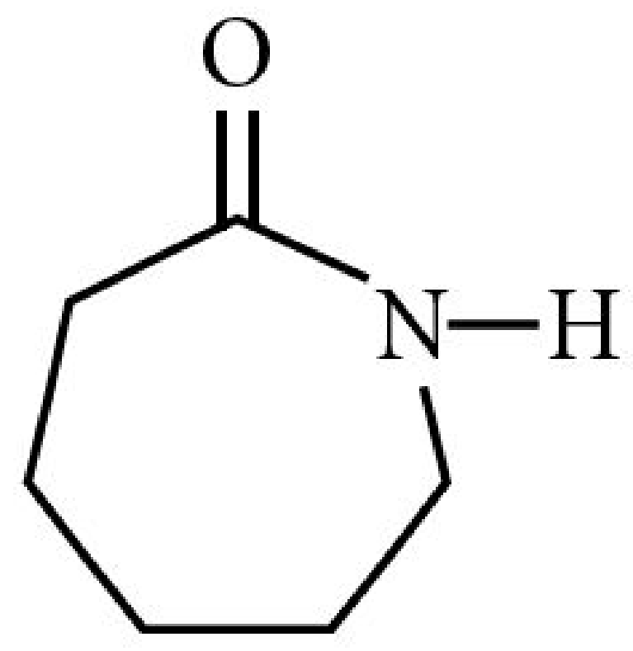
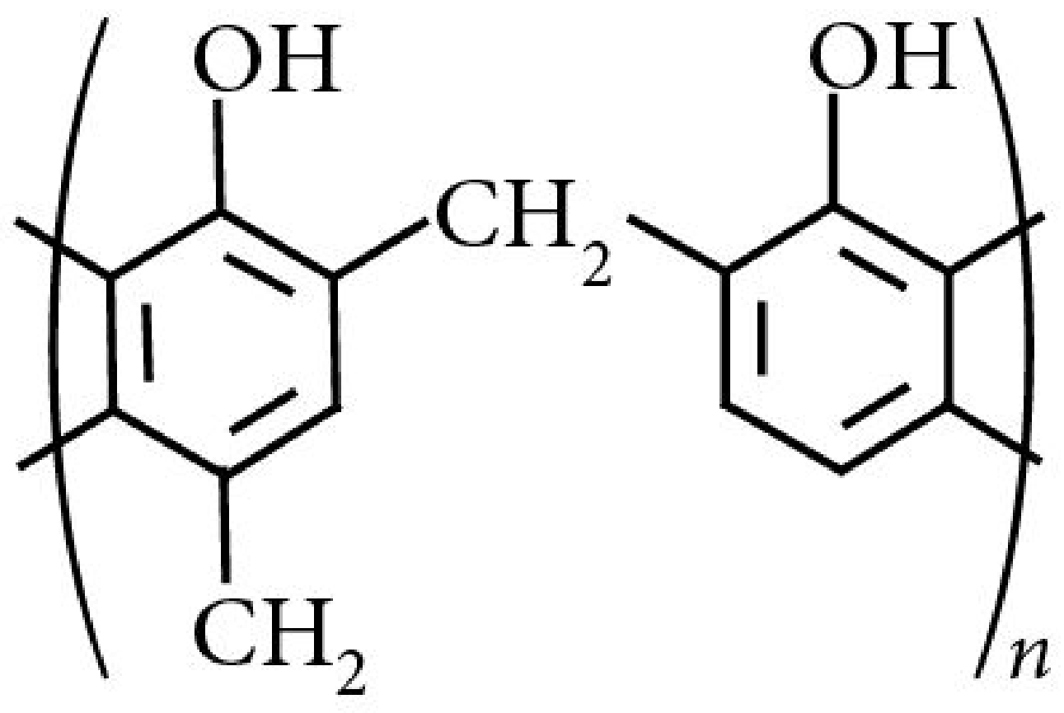
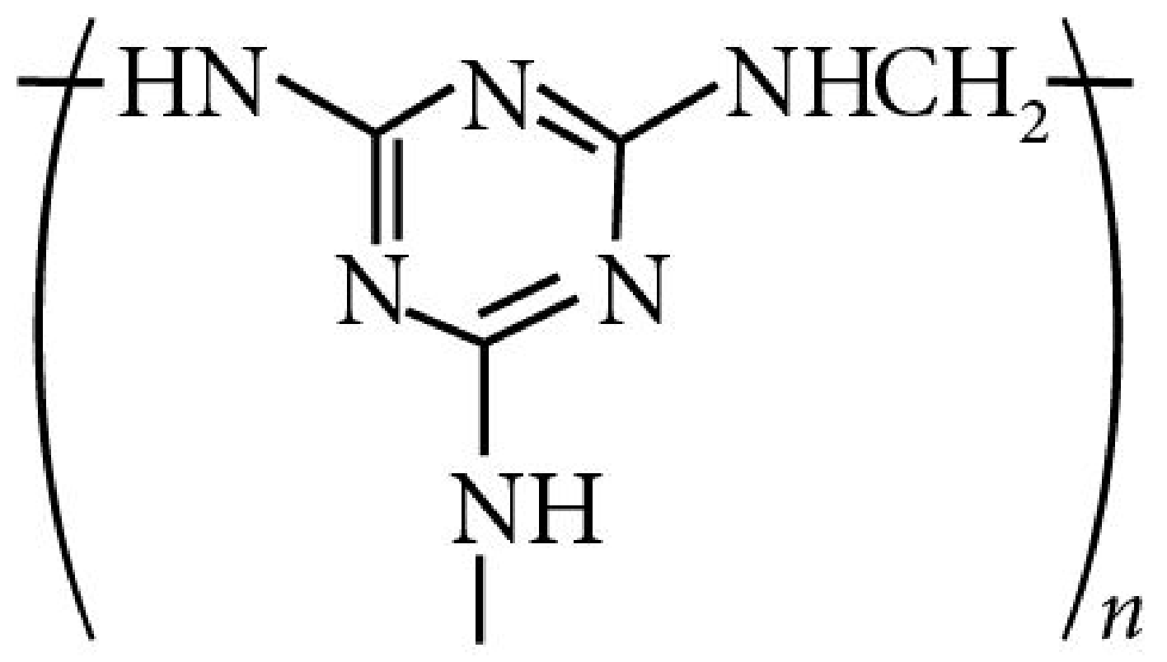
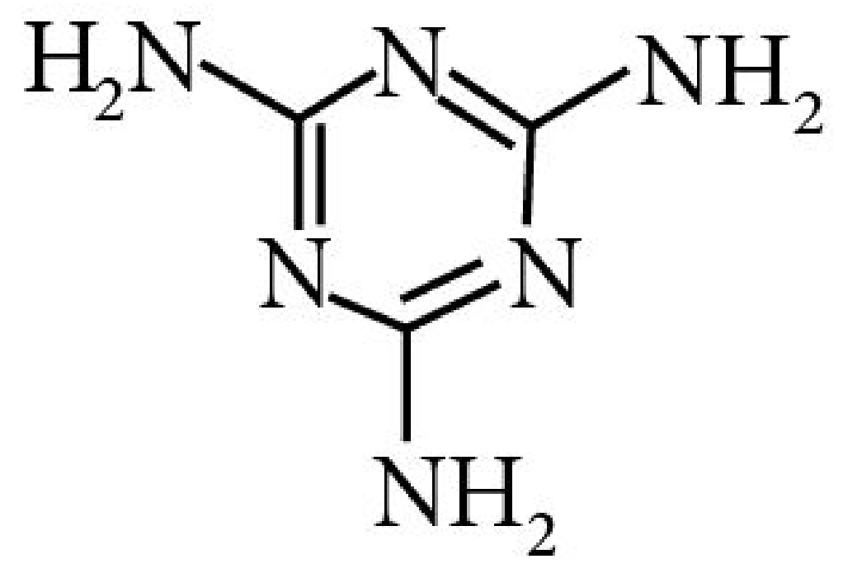
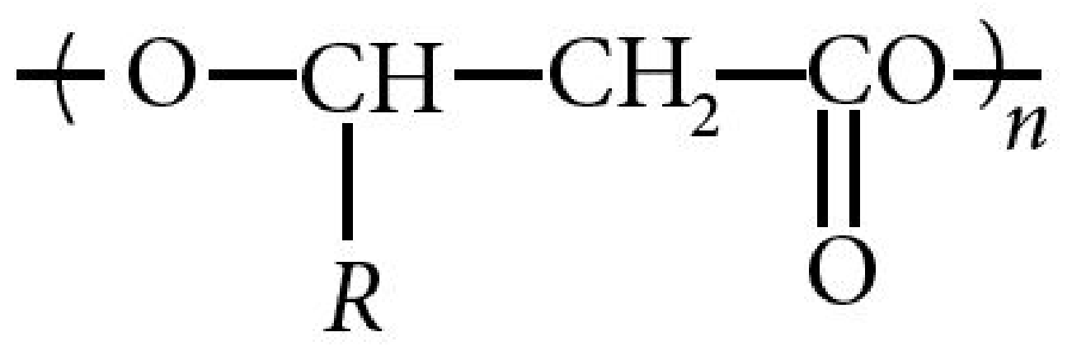
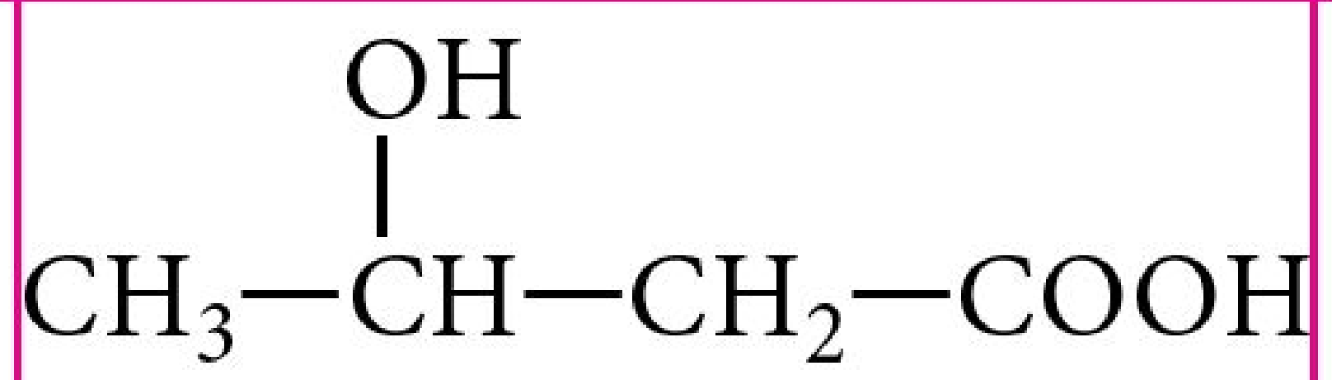
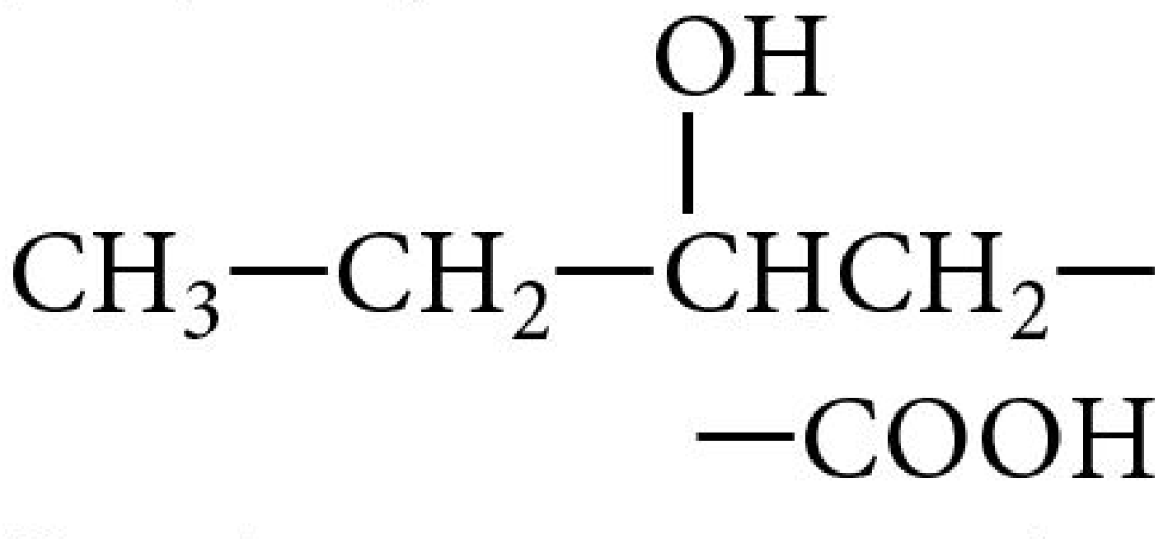


(b) β-pleated sheet structure
(Intermolecular hydrogen bonding between peptide chains)

Some Commercially Important Polymers

In the following table we shall now give a brief account of the various commercially important polymers along with their structures and uses.

S.No.	Name of polymer	Structure	Monomer	Uses
1.	Polyethylene	$-\!\!(CH_2-CH_2)\!\!-_n$	$CH_2=CH_2$	As insulator, anticorrosive, packing material, household and laboratory wares.
2.	Polystyrene	 $\left(-CH(C_6H_5)-CH_2-\right)_n$	$C_6H_5-CH=CH_2$	Use for home insulation, wrapping material, manufacture of toys and household articles.
3.	Polyvinyl chloride	 $\left(-CH_2-CH(Cl)-\right)_n$	$CH_2=CHCl$	In manufacture of raincoats, hand bags, vinyl flooring, and leather clothes.
4.	Polytetrafluoroethylene (PTFE) or Teflon	$-\!\!(CF_2-CF_2)\!\!-_n$	$CF_2=CF_2$	As lubricant, insulator and making cooking wares.
5.	Polymethyl methyl acrylate (PMMA) or Plexi glass	 $\left(-CH_2-C(CH_3)(COOCH_3)-\right)_n$	 $CH_2=C(CH_3)-COOCH_3$	As substitute of glass and making decorative materials.
6.	Polyacrylonitrile (Orlon)	 $\left(-CH_2-CH(CN)-\right)_n$	$CH_2=CHCN$	In making synthetic fibres and synthetic wool.
7.	Styrene butadiene rubber (SBR or Buna-S)	 $\left(-CH_2-CH=CH-CH_2-CH_2-CH(C_6H_5)-\right)_n$	$CH_2=CH-CH=CH_2$ 1,3-butadiene $C_6H_5-CH=CH_2$ Styrene	In making automobile tyres and footwear.
8.	Nitrile rubber (Buna-N)	 $\left(-CH_2-CH=CH-CH_2-CH_2-CH(CN)-\right)_n$	$CH_2=CH-CH=CH_2$ 1,3-butadiene $H_2C=CH-CN$ Acrylonitrile	In making oil seals, manufacture of hoses and tank linings.
9.	Neoprene	 $\left(-CH_2-C(Cl)=CH-CH_2-\right)_n$	 $CH_2=C(Cl)-CH=CH_2$ 2-Chloro-1,3-butadiene	As insulator, making conveyor belts and printing rollers.

10.	Polyethyl acrylate	 $\left(-CH_2-\underset{\underset{COOC_2H_5}{\vert}}{CH}-\right)_n$	$CH_2{=}CH-COOC_2H_5$	In making films, house pipes and finishing fabrics.
11.	Terylene (Dacron)		 Terephthalic acid $HO-CH_2-CH_2-OH$ Ethylene glycol	For making films, house pipes and finishing fabrics.
12.	Glyptal		 Phthalic acid $HO-CH_2-CH_2-OH$ Ethylene glycol	As binding material in preparation of mixed plastics and paints.
13.	Nylon-6	 $\left(-NH-(CH_2)_5-\overset{\overset{O}{\Vert}}{C}-\right)_n$	 Carprolactam	In making fibres, plastrics, tyre cords and ropes.
14.	Nylon-6,6	$-(NH(CH_2)_6NHCO(CH_2)_4CO)_n$	$HOOC-(CH_2)_4-COOH$ Adipic acid $H_2N-(CH_2)_6-NH_2$ Hexamethylene diamine	In making brushes, synthetic fibres, parachutes, ropes and carpets.
15.	Bakelite		HCHO Formaldehyde C_6H_5OH Phenol	For making gears, protective coating and electrical fittings.
16.	Urea formaldehyde resin	$-(NH(CH_2)_6NHCO(CH_2)_4CO)_n-$	HCHO Formaldehyde NH_2CONH_2 Urea	For making unbreakable cups and laminated sheets.
17.	Melamine formaldehyde resin		 2,4,6-Triamino-1,3,5-triazine HCHO Formaldehyde	In making plastic crockery, unbreakable cups and plates.
18.	Poly-β-hydroxyl butyrate-β-hydroxyl valerate (PHBV)	 $-\left(O-\underset{\underset{R}{\vert}}{CH}-CH_2-\underset{\underset{O}{\Vert}}{C}O\right)_n-$ $R = CH_3, C_2H_5$	 $CH_3-\overset{\overset{OH}{\vert}}{CH}-CH_2-COOH$ β-Hydroxy butanoic acid  $CH_3-CH_2-\overset{\overset{OH}{\vert}}{C}HCH_2-COOH$ β-Hydroxy pentanoic acid	As packaging, orthopaedic devices and in controlled release of drug.

Practical Inorganic Chemistry

- **Identification of Basic Radicals**
  - **Separation of basic radicals into different groups :**

Basic radicals of	Group reagent	Precipitated as	Explanation
Group I Ag^+, Pb^{2+}, Hg_2^{2+}	dil. HCl	$AgCl$, $PbCl_2$, Hg_2Cl_2 (All white)	K_{sp} values of their chlorides are low, hence $K_{ip} > K_{sp}$ and they get precipitated.
Group II Hg^{2+}, Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, As^{3+}, Sb^{3+}, Sn^{2+}, Sn^{4+}	H_2S in presence of dil. HCl	HgS, PbS, Bi_2S_3, CuS (Black), CdS, As_2S_3, SnS_2 (Yellow), Sb_2S_3 (Orange), SnS (Brown), SnS_2 (yellow)	HCl (with common H^+ ion) decreases the ionization of H_2S which gives low $[S^{2-}]$. Hence, only group II sulphides having low K_{sp} values are precipitated.
Group III Fe^{3+}, Cr^{3+}, Al^{3+}	NH_4OH in presence of NH_4Cl	$Fe(OH)_3$ (Reddish brown), $Cr(OH)_3$ (Green), $Al(OH)_3$ (White)	NH_4Cl (with common NH_4^+ ion) decreases the ionization of NH_4OH giving low $[OH^-]$. Hence, only group III hydroxides having low K_{sp} values are precipitated.
Group IV Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}	H_2S in presence of NH_4OH	ZnS (Greenish white), MnS (Buff), CoS, NiS (Black),	Basic medium increases the ionization of H_2S, thus increasing $[S^{2-}]$, hence precipitation of group IV sulphides having high K_{sp} values occurs.
Group V Ba^{2+}, Sr^{2+}, Ca^{2+}	$(NH_4)_2CO_3$ in presence of NH_4OH	$BaCO_3$, $SrCO_3$, $CaCO_3$ (All white)	K_{sp} values of their carbonates are less than that of group VI (Mg^{2+}) hence, group V is precipitated before Mg^{2+}.
Group VI Mg^{2+}	Na_2HPO_4 in presence of NH_4OH	$Mg(NH_4)PO_4$ (White)	—
Zero NH_4^+	NaOH	Ammonia gas is evolved.	Tested independently from original solution.

  - **Confirmation of basic radicals of different groups :**

Precipitates of	Confirmatory tests
Group I	
$AgCl$	Dissolves in NH_4OH, white ppt. of $AgCl$ is again obtained on adding dil. HNO_3. Yellow ppt. of AgI is formed on adding KI.
$PbCl_2$	Dissolves in hot water, gives yellow ppt. of $PbCrO_4$ with K_2CrO_4 and yellow ppt. of PbI_2 with KI.
Hg_2Cl_2	Turns black with NH_4OH. Black residue $\{Hg + Hg(NH_2)Cl\}$ dissolves in aqua-regia.
Group II A	Precipitates do not dissolve in yellow ammonium sulphide.
HgS	Dissolves in aqua-regia, grey ppt. of Hg is obtained with $SnCl_2$ or Cu turnings.
PbS	Dissolves in dil. HNO_3, white ppt. of $PbSO_4$ is obtained on adding dil. H_2SO_4.
Bi_2S_3	Dissolves in dil. HCl, white ppt. of $BiOCl$ is obtained on adding excess of water. Black ppt. of Bi is obtained on adding Na_2SnO_2 solution.

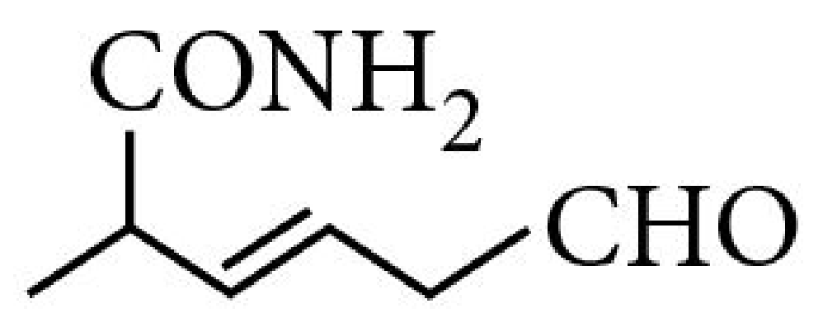
CuS	Blue coloured solution is obtained on adding dil. HNO_3 and excess of NH_4OH which gives chocolate brown ppt. of $Cu_2[Fe(CN)_6]$ with $K_4[Fe(CN)_6]$.
CdS	Colourless solution is obtained on adding dil. HNO_3 and excess of NH_4OH which gives yellow ppt. of CdS again on adding H_2S.
Group II B	Precipitates dissolve in yellow ammonium sulphide.
As_2S_3	Insoluble sulphide, As_2S_5 is obtained by treating with conc. HCl which gives yellow ppt. of ammonium arsenomolybdate on adding conc. HNO_3 and heating with ammonium molybdate.
SnS_2 or SnS	Filtrate of sulphide in conc. HCl is reduced to $SnCl_2$ by treating with Fe or Zn which, on adding $HgCl_2$ solution initially gives white ppt. of Hg_2Cl_2 and finally turns to grey Hg.
Sb_2S_3	Filtrate of sulphide in conc. HCl gives white ppt. of SbOCl on adding excess of water and orange ppt. of Sb_2S_3 on passing H_2S gas.
Group III	
$Fe(OH)_3$	Dissolves in dil. HCl, gives prussian blue solution or ppt. of $Fe_4[Fe(CN)_6]_3$ on adding $K_4[Fe(CN)_6]$ and blood red coloured $Fe(CNS)_3$ on adding KCNS.
$Cr(OH)_3$	The solution obtained on heating precipitate with NaOH and Br_2 water contains Na_2CrO_4 which gives yellow ppt. of $PbCrO_4$ on treating with acidified lead acetate solution.
$Al(OH)_3$	Dissolves in NaOH and is again precipitated out on boiling with NH_4Cl gives gelatinous white ppt.
Group IV	Soluble in conc. HCl
ZnS	Solution ($ZnCl_2$) is treated with NaOH, a white ppt. of $Zn(OH)_2$ appears which dissolves in excess of NaOH and on passing H_2S, white ppt. of ZnS is obtained.
MnS	Precipitate of MnO_2 is obtained on heating the solution with NaOH and Br_2 water. Pink colour of $HMnO_4$ is formed on supernatant liquid on treating the ppt. with excess of HNO_3 and red lead (Pb_3O_4).
Group IV	Insoluble in conc. HCl
CoS	Dissolves in aqua-regia. Yellow ppt. of potassium cobalt nitrite $K_3[Co(NO_2)_6]$ is obtained on adding CH_3COOH in excess and KNO_2.
NiS	Dissolves in aqua-regia. Red ppt. of Ni-dmg complex is obtained on adding NH_4OH in excess and dimethyl glyoxime.
Group V	Soluble in acetic acid
$BaCO_3$	Yellow ppt. of $BaCrO_4$ is obtained on adding K_2CrO_4 to solution.
$SrCO_3$	White ppt. of $SrSO_4$ is obtained on adding $(NH_4)_2SO_4$ to solution.
$CaCO_3$	White ppt. of CaC_2O_4 is obtained on adding $(NH_4)_2C_2O_4$.
Group VI	
Mg^{2+}	White ppt. of $Mg(NH_4)PO_4$ is formed on adding Na_2HPO_4 and NH_4OH to solution.
Zero	
NH_4^+	Salt evolves NH_3 gas on heating with NaOH which gives dense white fumes of NH_4Cl with HCl and a brown ppt. of $H_2N{\cdot}HgO{\cdot}HgI$ on adding Nessler's reagent, K_2HgI_4.

COMEDK

Exam on 10th May

PRACTICE PAPER 2025

1. The IUPAC name of the compound



is

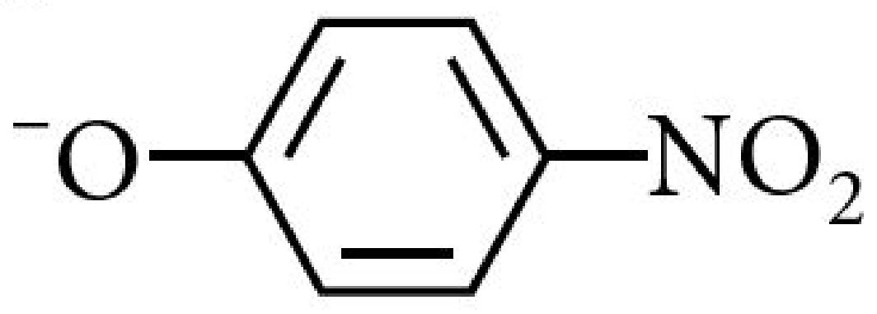
(a) 5-carbamoylhex-1-enal
(b) 2-carbamoylhex-3-enal
(c) 2-methyl-6-oxohex-3-enamide
(d) 6-keto-2-methylhexanamide.

2. Which of the following has highest molar conductivity?

(a) Diamminedichloroplatinum(II)
(b) Tetraamminedichlorocobalt(III) chloride
(c) Potassium hexacyanoferrate(II)
(d) Pentacarbonyliron(0)

3. Which of the following species is the strongest base?

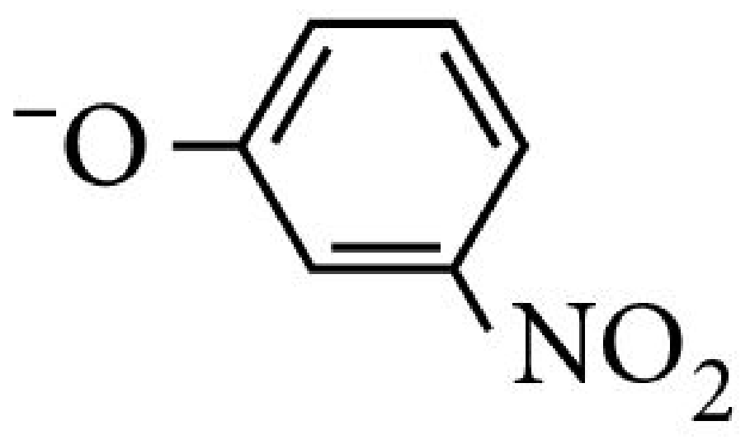
(a)



(b) ^{-}OR

(c) $^{-}OC_6H_5$

(d)



4. We have three aqueous solutions of NaCl labelled as '*A*', '*B*' and '*C*' with concentrations 0.1 M, 0.01 M and 0.001 M, respectively. The value of van't Hoff factor for these solutions will be in the order

(a) $i_A < i_B < i_C$
(b) $i_A > i_B > i_C$
(c) $i_A = i_B = i_C$
(d) $i_A < i_B > i_C$

5. For the reaction,

$$H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)}$$

$B.E._{(H-H)} = x_1$; $B.E._{(O=O)} = x_2$ and $B.E._{(O-H)} = x_3$.
If the latent heat of vaporisation of water liquid into water vapour = x_4, then $\Delta_f H$ (heat of formation of liquid water) is

(a) $x_1 + \frac{x_2}{2} - x_3 + x_4$
(b) $2x_3 - x_1 - \frac{x_2}{2} - x_4$
(c) $x_1 + \frac{x_2}{2} - 2x_3 - x_4$
(d) $x_1 + \frac{x_2}{2} - 2x_3 + x_4$

6. If the equilibrium constant of $BOH \rightleftharpoons B^+ + OH^-$ at 25°C is 2.5×10^{-6}, then equilibrium constant for $BOH + H^+ \rightleftharpoons B^+ + H_2O$ at the same temperature is

(a) 4.0×10^{-9}
(b) 4.0×10^{5}
(c) 2.5×10^{8}
(d) 2.5×10^{-6}

7. Which is finally produced when acetylene reacts with HCl?

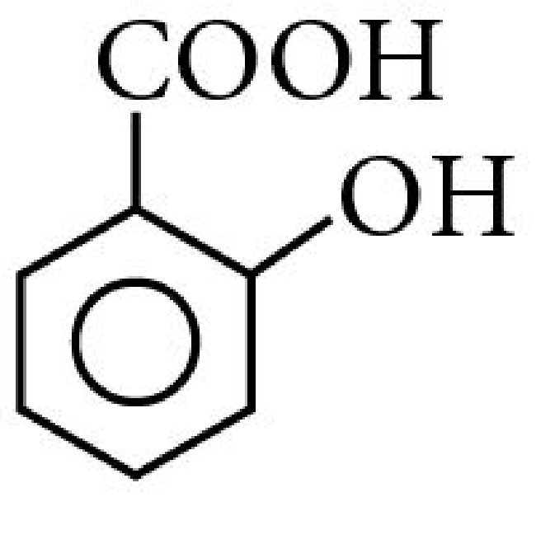
(a) $CH_2{=}CHCl$
(b) CH_3CHCl_2
(c) $ClCH{=}CHCl$
(d) None of these

8. The ligand called π-acid is

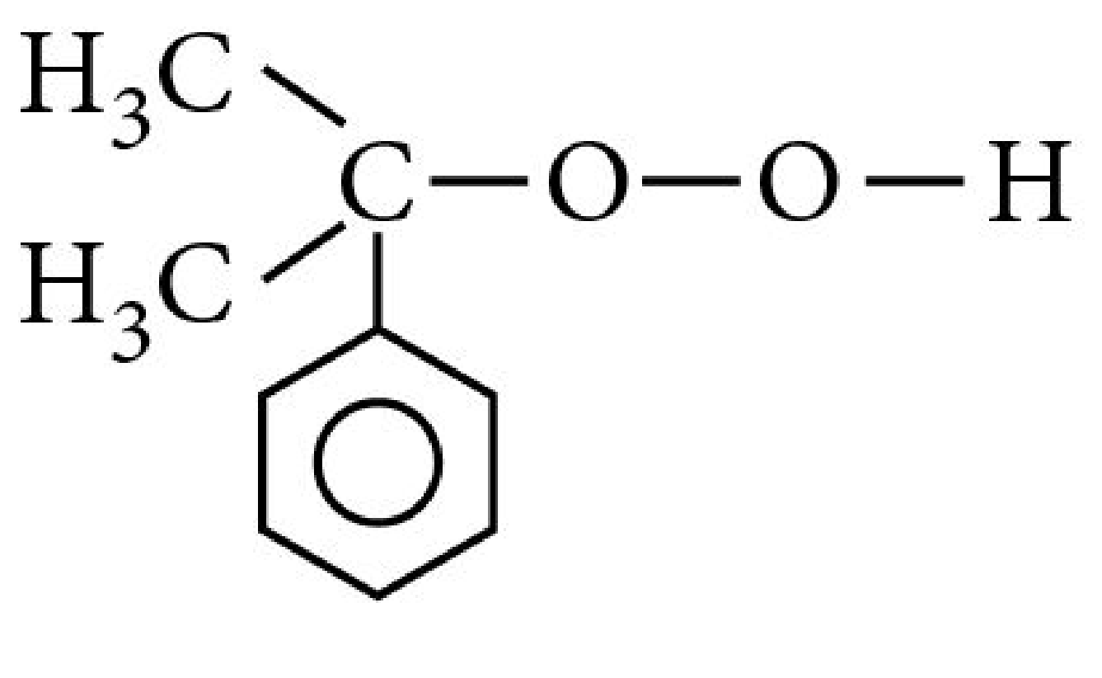
(a) CO
(b) NH_3
(c) $C_2O_4^{2-}$
(d) ethylenediamine.

9. Phenol is distilled with Zn dust followed by Friedel–Crafts alkylation with propyl chloride in the presence of $AlCl_3$ to give a compound *B*. *B* is oxidised in the presence of air to form the compound *C*. The structural formula of *C* is

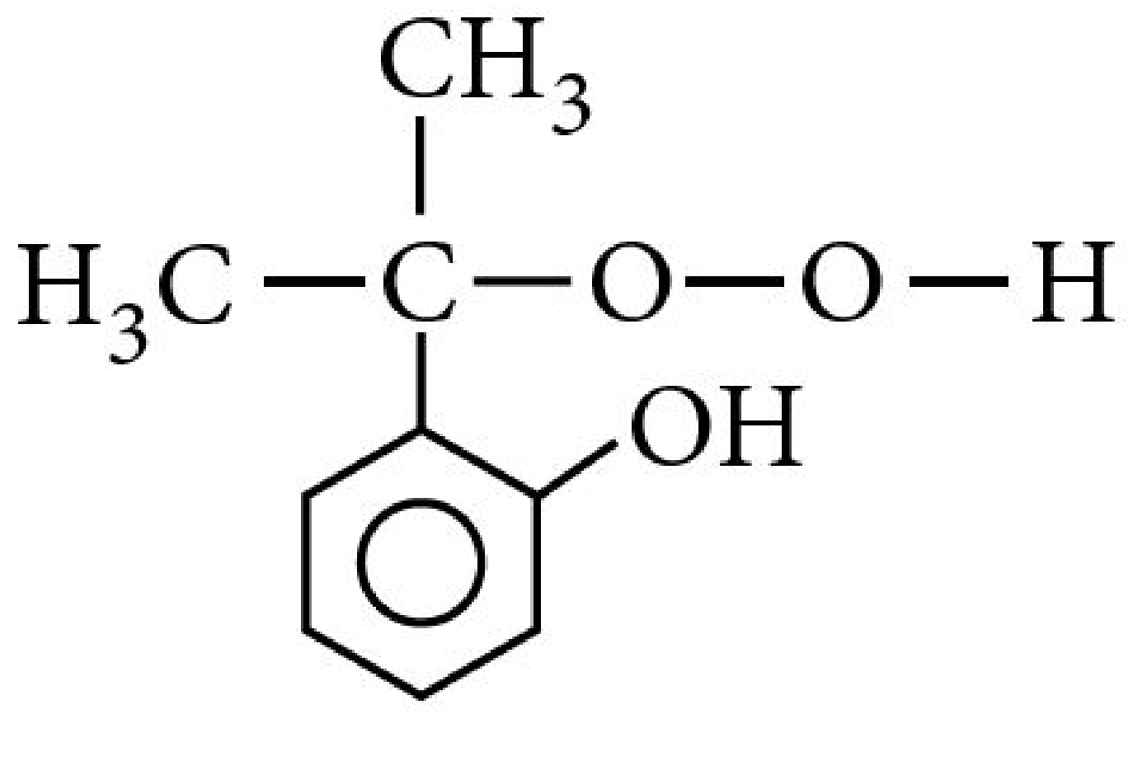
(a)



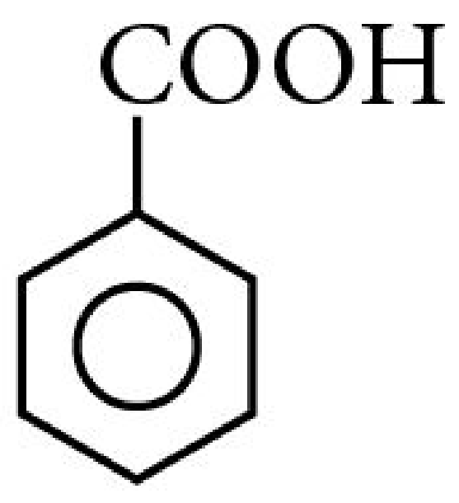
(b)



(c)



(d)



10. $\Lambda^\circ_{m(NH_4OH)}$ is equal to

(a) $\Lambda^\circ_{m(NH_4OH)} + \Lambda^\circ_{m(NH_4Cl)} - \Lambda^\circ_{m(HCl)}$
(b) $\Lambda^\circ_{m(NH_4Cl)} + \Lambda^\circ_{m(NaOH)} - \Lambda^\circ_{m(NaCl)}$
(c) $\Lambda^\circ_{m(NH_4Cl)} + \Lambda^\circ_{m(NaCl)} - \Lambda^\circ_{m(NaOH)}$
(d) $\Lambda^\circ_{m(NaOH)} + \Lambda^\circ_{m(NaCl)} - \Lambda^\circ_{m(NH_4Cl)}$

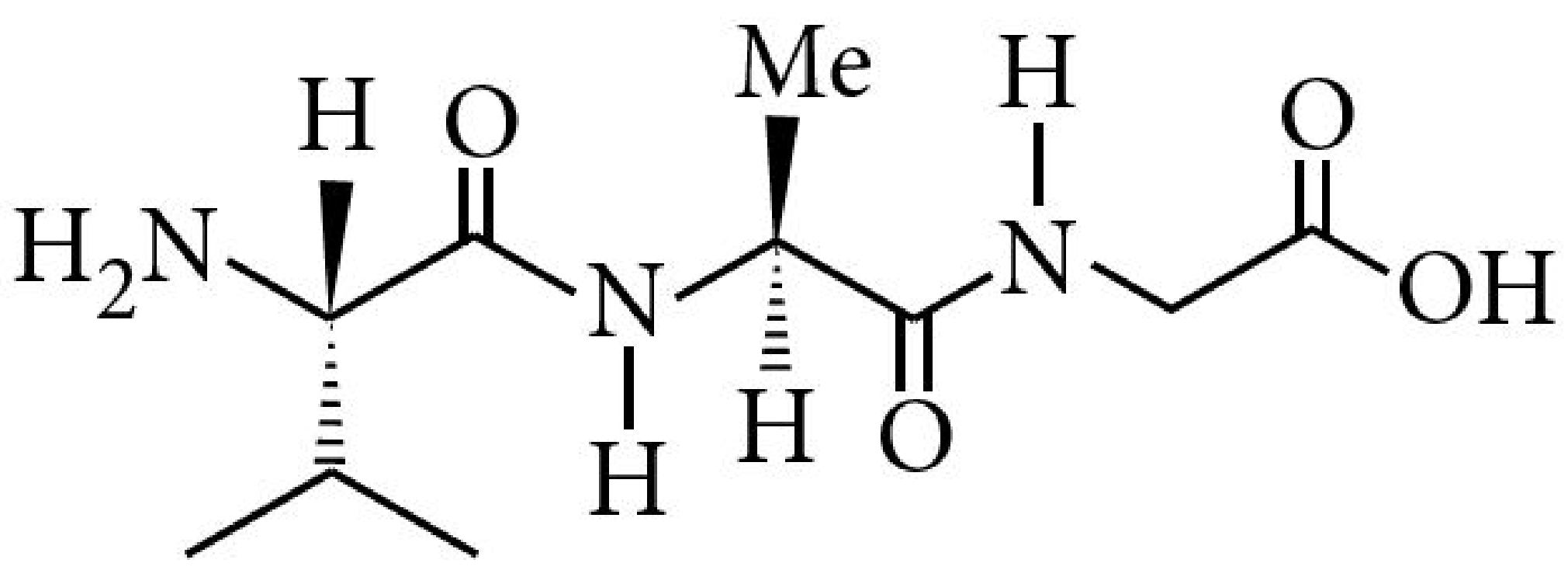
11. Distinction between primary, secondary and tertiary alcohols is done by

(a) oxidation method (b) Lucas test
(c) Victor Meyer method
(d) all of these.

12. The frequency of radiation emitted when the electron falls from $n = 4$ to $n = 1$ in a hydrogen atom will be

(a) $3.08 \times 10^{15}\ s^{-1}$ (b) $2.00 \times 10^{15}\ s^{-1}$
(c) $1.54 \times 10^{15}\ s^{-1}$ (d) $1.03 \times 10^{15}\ s^{-1}$

13. Which of the following amino acids can be used to synthesise the given tripeptide ?



(a) Glycine, leucine and alanine
(b) Alanine, isoleucine and glycine
(c) Valine, alanine and glycine
(d) Alanine, serine and glycine

14. In the anion $HCOO^-$ the two carbon-oxygen bonds are found to be of equal length because

(a) the C═O bond is weaker than the C—O bond
(b) the anion $HCOO^-$ shows resonance
(c) the anion is obtained by removal of a proton from the acid molecule
(d) the electronic orbitals of carbon atom are hybridised.

15. In chromic acid anhydride (CrO_3), Cr has d^0 configuration but it is bright orange coloured solid, the colour is due to

(a) *d*-*d* transition
(b) charge transfer ($L \rightarrow M$) transition
(c) charge transfer ($M \rightarrow L$) transition
(d) *p*-*d* transition.

16. A cylinder filled with a movable piston contains liquid water in equilibrium with water vapours at 25°C. Which one of the following operations results in a decrease in the equilibrium vapour pressure?

(a) Moving the piston downward a short distance
(b) Removing a small amount of vapour
(c) Removing a small amount of the liquid water
(d) Dissolving salt in the water

17. The carbohydrate that yields glucose and galactose on acid hydrolysis is

(a) sucrose (b) lactose (c) maltose (d) starch.

18. The correct order of the ligands, OH^-, NO_3^-, PPh_3, pyridine, according to their increasing field strength is

(a) $SCN^- < OH^- < NCS^- < CO$
(b) $OH^- < SCN^- < CO < NCS^-$
(c) $OH^- < SCN^- < NCS^- < CO$
(d) $SCN^- < OH^- < CO < NCS^-$

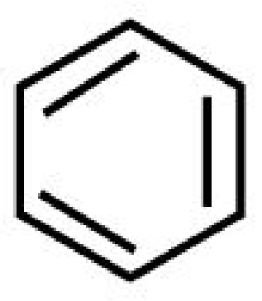
19. Consider the following sets of quantum numbers :

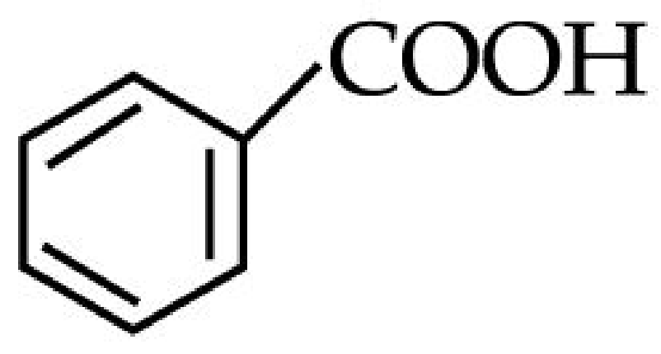
	n	*l*	*m*	*s*
(i)	3	0	0	+1/2
(ii)	2	2	1	+1/2
(iii)	4	3	−2	−1/2
(iv)	1	0	−1	−1/2
(v)	3	2	3	+1/2

Which of the following sets of quantum number is not possible?

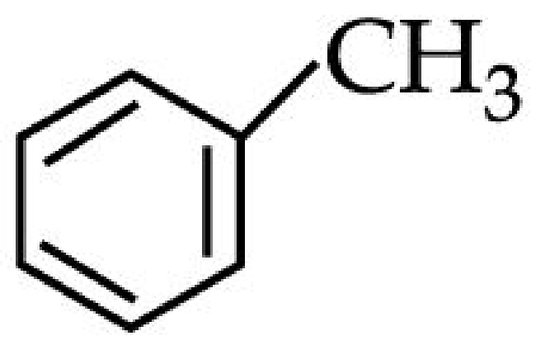
(a) (i), (ii), (iii) and (iv) (b) (ii), (iv) and (v)
(c) (i) and (iii) (d) (ii), (iii) and (iv)

20. Reaction by which benzaldehyde cannot be prepared is

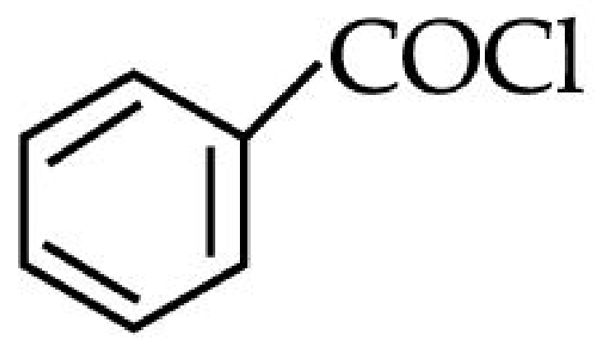
(a)  + CO + HCl in presence of anhydrous $AlCl_3$

(b) 

+ Zn/Hg and conc. HCl

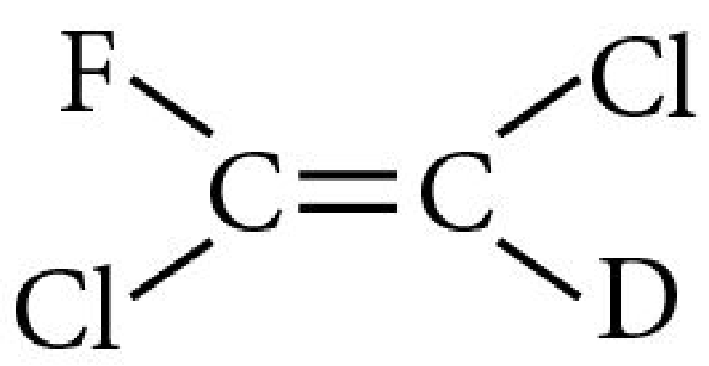
(c) 

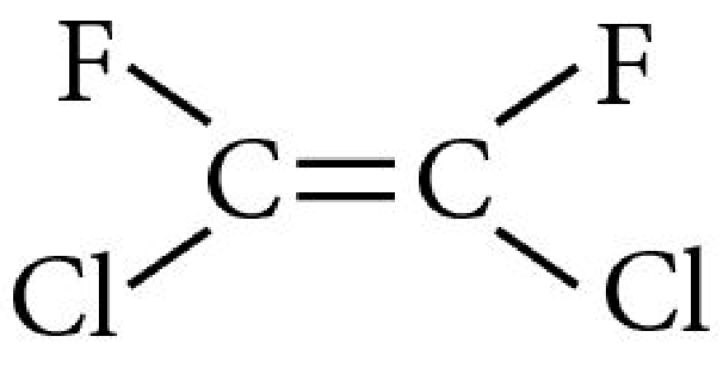
+ CrO_2Cl_2 in CS_2 followed by H_3O^+

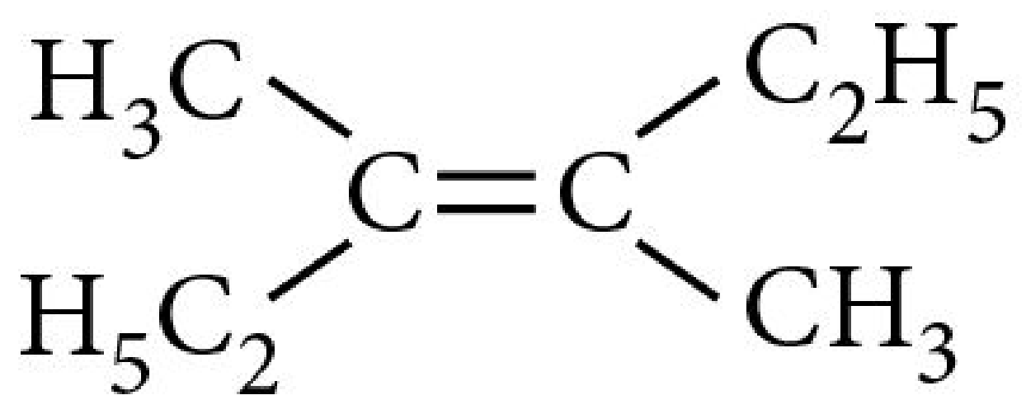
(d) 

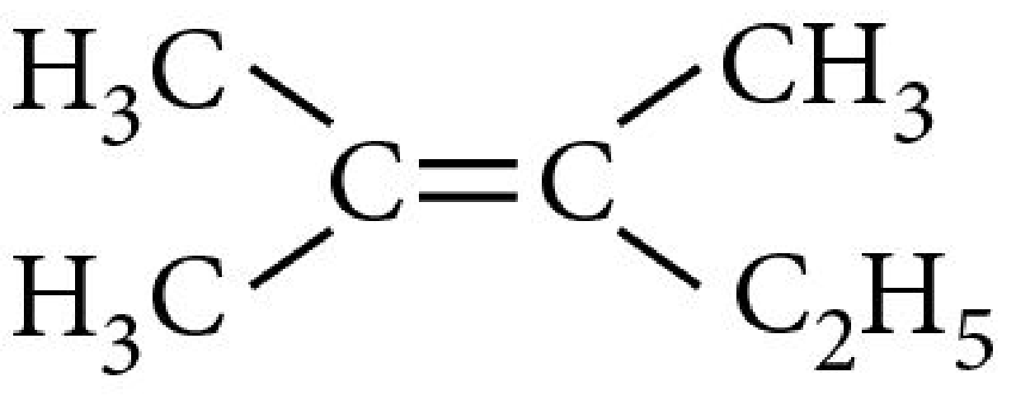
+ H_2 in presence of Pd-$BaSO_4$

21. Which of the following will not show geometrical isomerism?

(a) 
$$\overset{F}{\underset{Cl}{}}C{=}C\overset{Cl}{\underset{D}{}}$$

(b) 
$$\overset{F}{\underset{Cl}{}}C{=}C\overset{F}{\underset{Cl}{}}$$

(c) 
$$\overset{H_3C}{\underset{H_5C_2}{}}C{=}C\overset{C_2H_5}{\underset{CH_3}{}}$$

(d) 
$$\overset{H_3C}{\underset{H_3C}{}}C{=}C\overset{CH_3}{\underset{C_2H_5}{}}$$

22. Following data is given at 25°C,

$Ag + I^- \longrightarrow AgI + e^-$; $E° = 0.152$ V

$Ag \longrightarrow Ag^+ + e^-$; $E° = -0.800$ V

What is the value of log K_{sp} for AgI?

(a) – 37.83 (b) – 16.13 (c) – 8.12 (d) + 8.612

23. If the concentration of glucose ($C_6H_{12}O_6$) in blood is 0.9 g L^{-1}, what will be the molarity of glucose in blood?

(a) 5 M (b) 50 M (c) 0.005 M (d) 0.5 M

24. If $\Delta_o < P$, the correct electronic configuration for d^4 system will be

(a) $t_{2g}^3 e_g^1$ (b) $t_{2g}^4 e_g^0$ (c) $t_{2g}^0 e_g^4$ (d) $t_{2g}^2 e_g^2$

25. An energy of 24.6 eV is required to remove one of the electrons from a helium atom. The total energy required to remove both the electrons from helium atom is

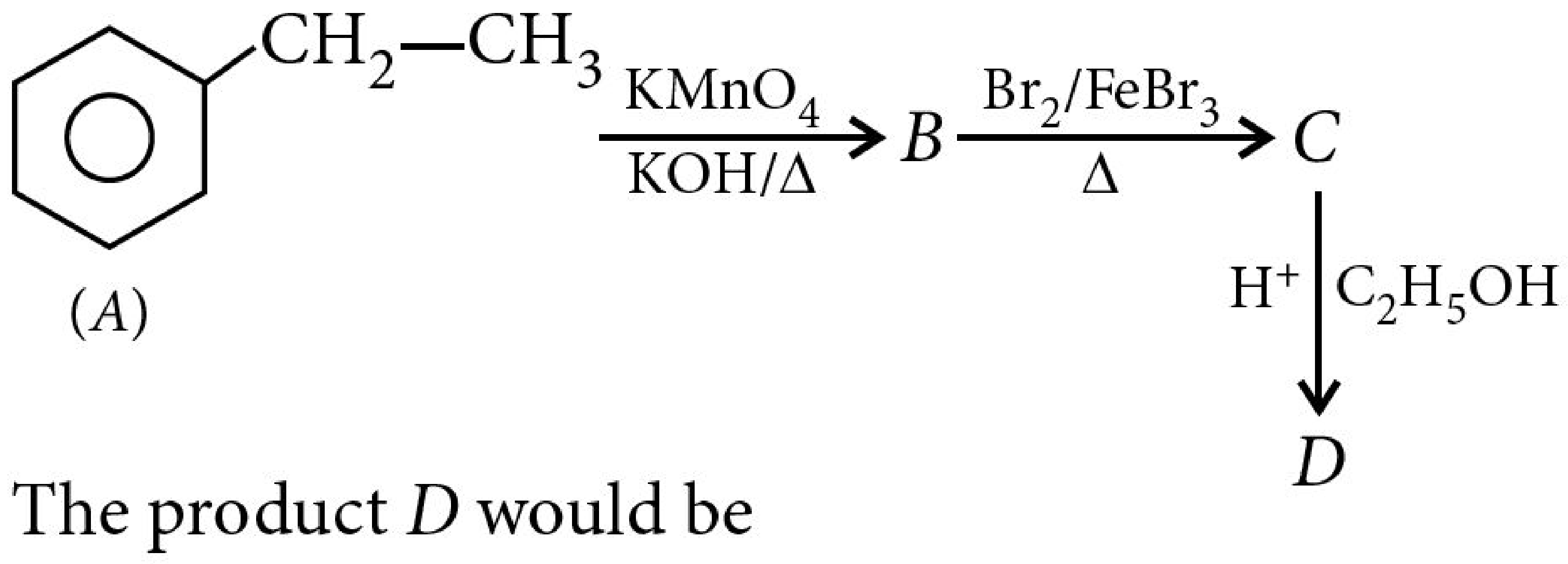
(a) 38.2 eV (b) 49.2 eV (c) 51.8 eV (d) 79.0eV

26. A first order reaction is 15% completed in 20 minutes. How long will it take to complete 60% ?

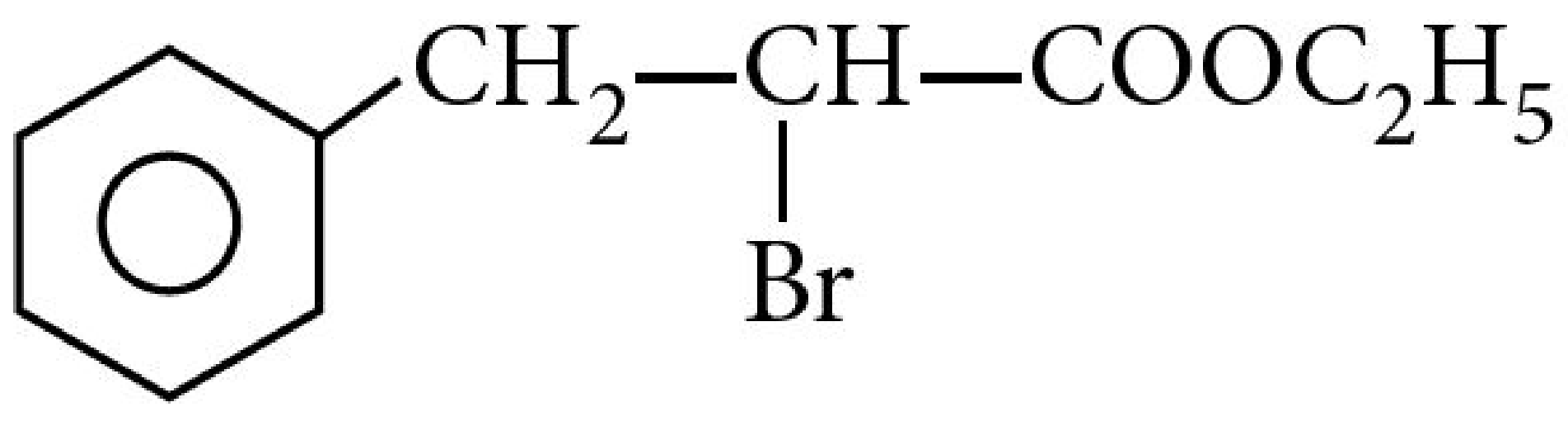
(a) 123.3 minutes (b) 112.7 minutes

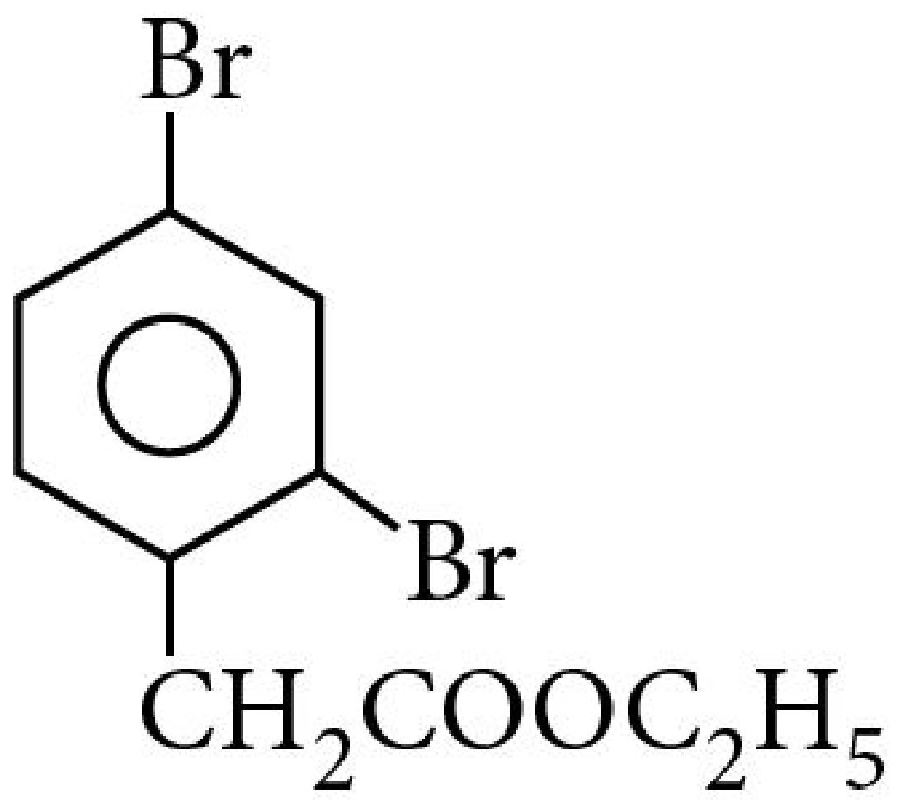
(c) 145.2 minutes (d) 138.8 minutes

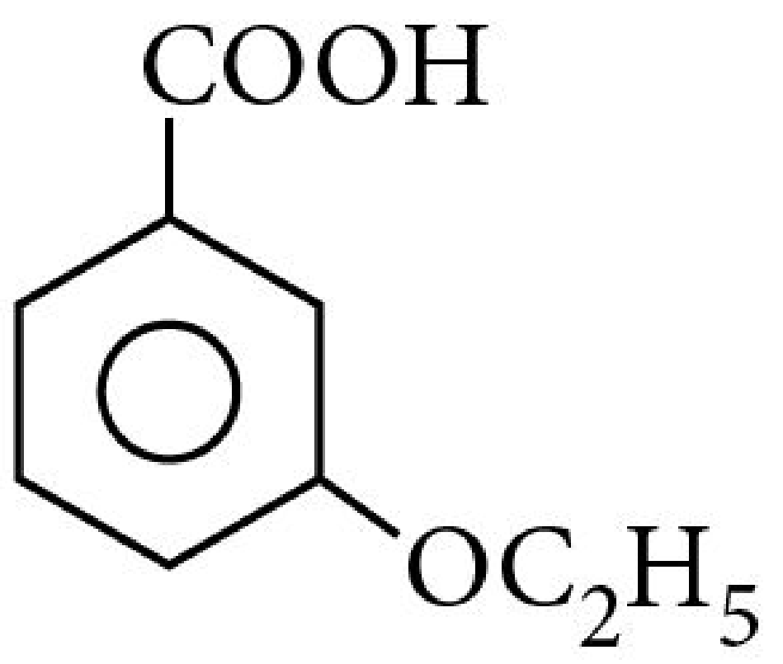
27. In a set of reactions, ethyl benzene yielded a product *D*.

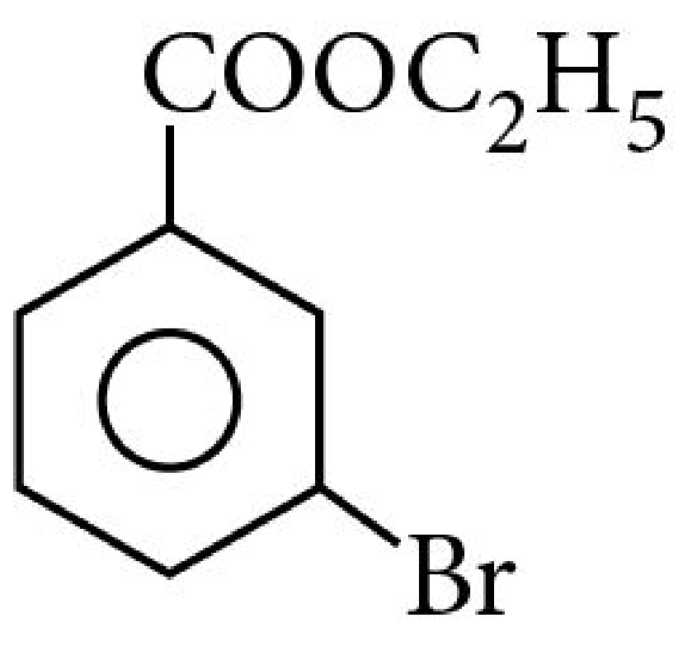

CH₂—CH₃
(A)
KMnO₄
KOH/Δ
B
Br₂/FeBr₃
Δ
C
H⁺
C₂H₅OH
D

The product *D* would be

(a) 
CH₂—CH—COOC₂H₅
Br

(b) 
Br
Br
CH₂COOC₂H₅

(c) 

(d) 

28. *m*-Bromoaniline can be prepared by

(a) $C_6H_6 \xrightarrow[H_2SO_4]{HNO_3} \xrightarrow[\text{(ii) NaOH, } H_2O]{\text{(i) Sn–HCl}} \xrightarrow[H_2O]{Br_2}$

(b) $C_6H_6 \xrightarrow[FeBr_3]{Br_2} \xrightarrow[H_2SO_4]{HNO_3} \xrightarrow[Pt]{H_2}$

(c) $m\text{-}BrC_6H_4COOH \xrightarrow{SOCl_2} \xrightarrow{NH_3} \xrightarrow{Br_2,\ NaOH}$

(d) $C_6H_5NH_2 \xrightarrow[Cu_2Br_2]{NaNO_2,\ HCl} \xrightarrow{NaNH_2}$

29. The lattice enthalpy and hydration enthalpy of four compounds are given below :

Compounds	**Lattice enthalpy (in kJ mol^{-1})**	**Hydration enthalpy (in kJ mol^{-1})**
P	+ 780	– 920
Q	+ 1012	– 812
R	+ 828	– 878
S	+ 632	– 600

The pair of compounds which is soluble in water is

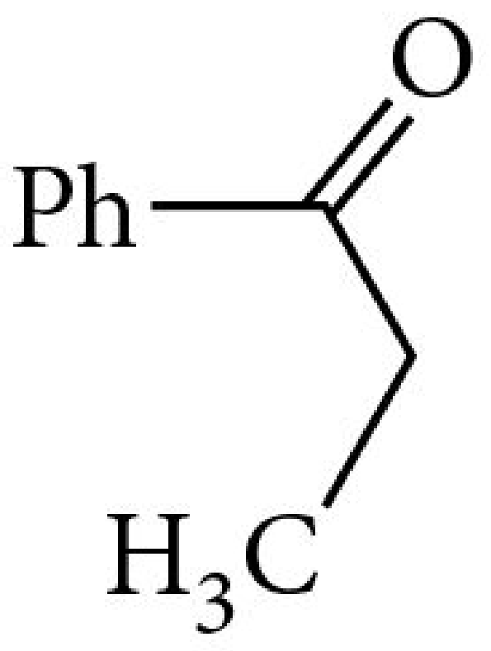
(a) *P* and *Q* (b) *Q* and *R*

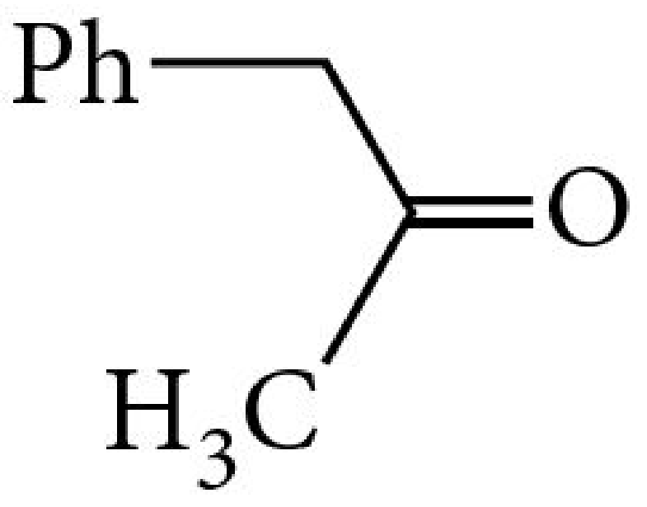
(c) *R* and *S* (d) *P* and *R*

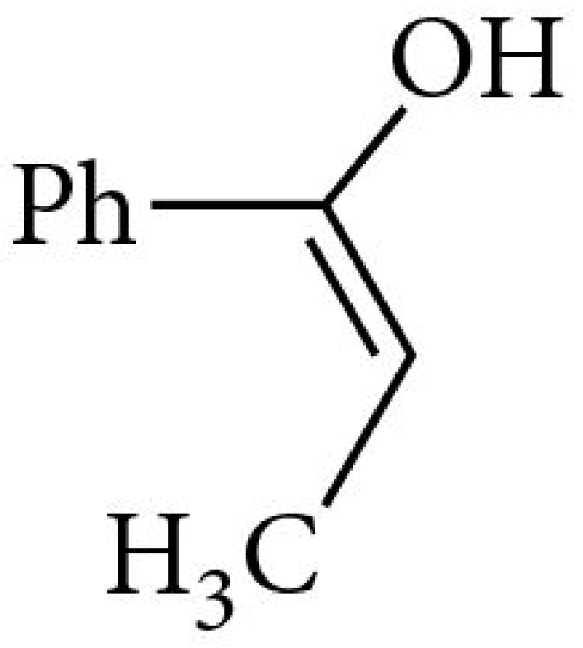
30. In the following reaction,

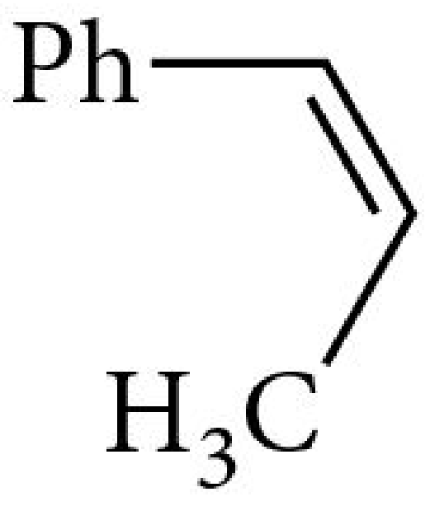
$$Ph—C{\equiv}C—CH_3 \xrightarrow[H_2O]{Hg^{2+}/H^+} A$$

A is

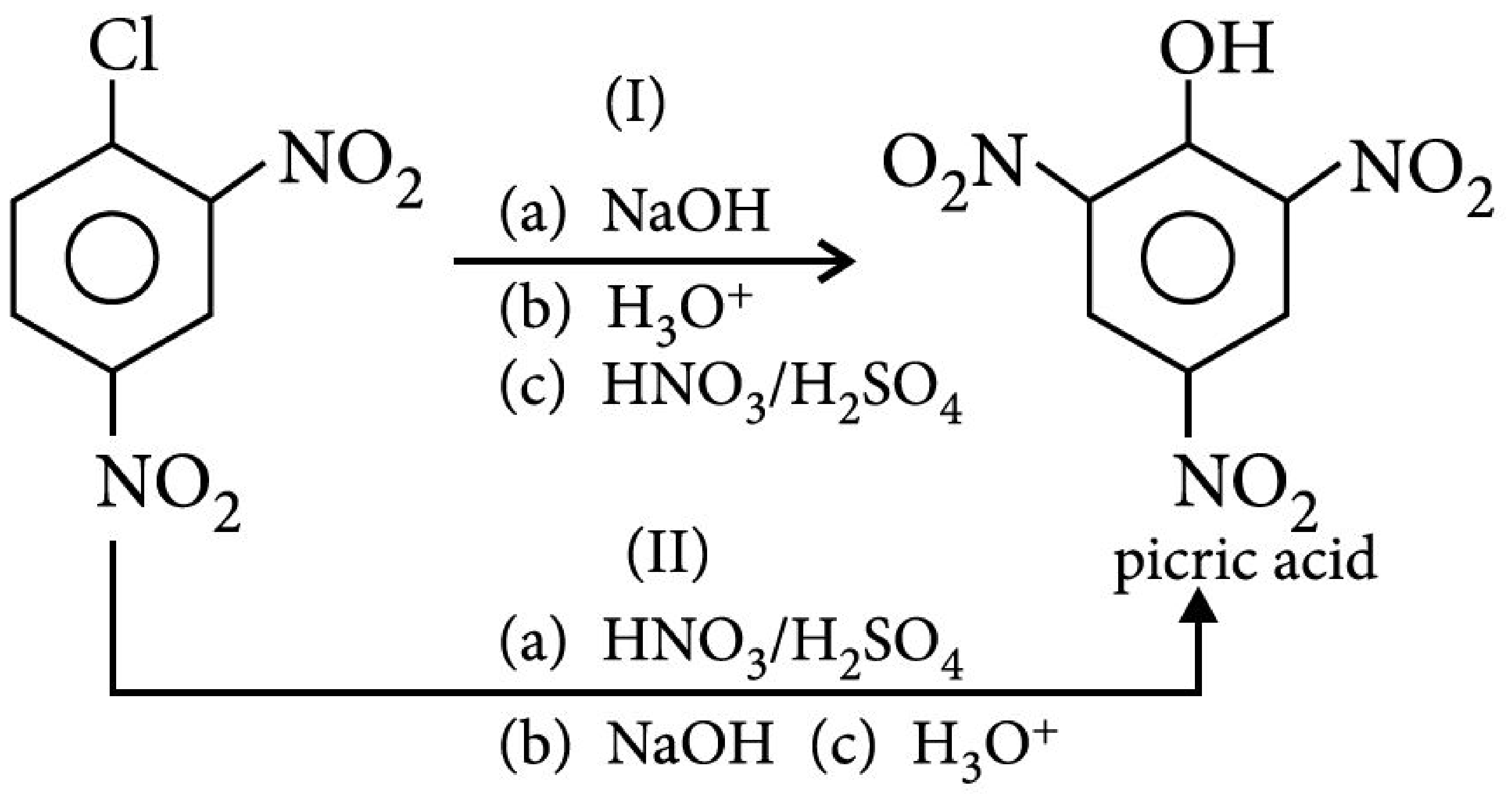
(a) 

(b) 

(c) 

(d) 

31. Picric acid can be obtained by path I or II from 2, 4-dinitrochlorobenzene.


Cl
NO₂
NO₂
(I)
(a) NaOH
(b) H₃O⁺
(c) HNO₃/H₂SO₄
OH
O₂N
NO₂
NO₂
picric acid
(II)
(a) HNO₃/H₂SO₄
(b) NaOH (c) H₃O⁺

Which is possible path?

(a) Path I (b) Path II

(c) Both I and II (d) Both are not possible

32. The equilibrium constant value for the equilibrium :

$$H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$$

changes with

(a) total pressure

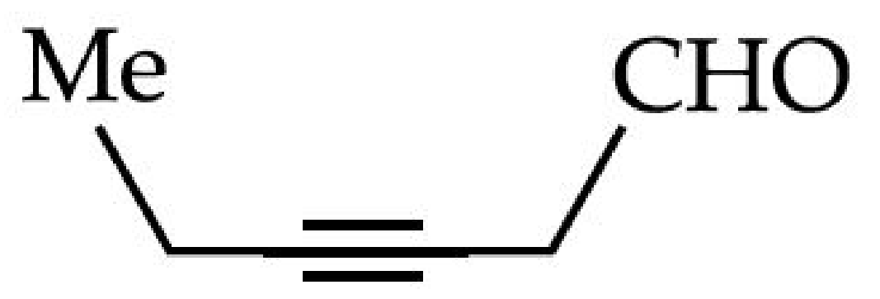
(b) temperature

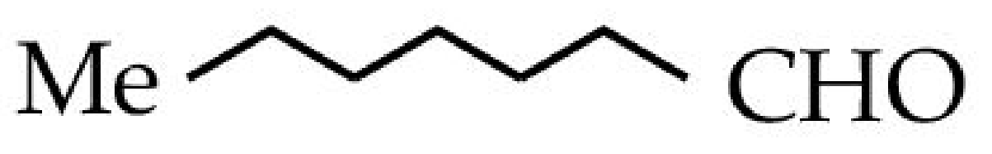
(c) catalyst

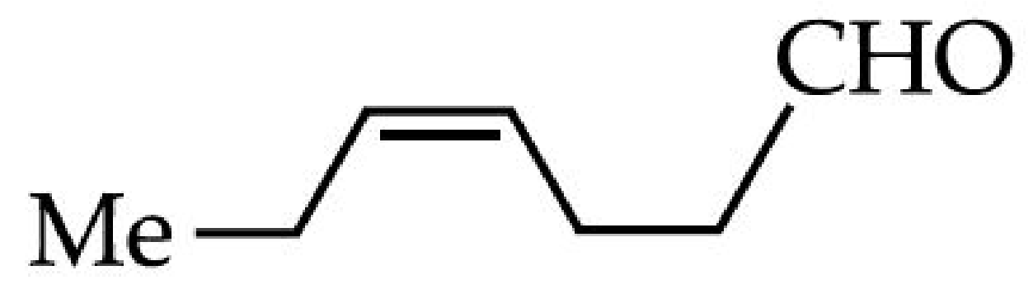
(d) amount of H_2 and I_2 present.

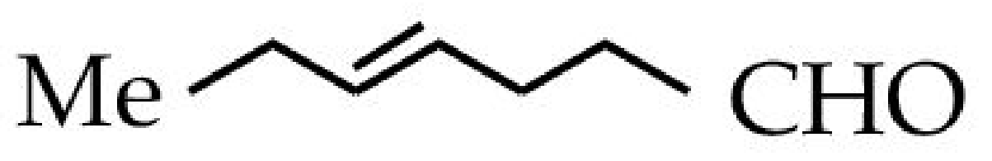
33. Identify 'S' in the following reaction sequence :

$$\begin{tikzcd} \text{Hex-3-ynal} \arrow[r, "(1)\ NaBH_4"', "(2)\ PBr_3"'] & P \arrow[r, "\substack{(1)\ Mg/ether\\(2)\ CO_2}", "(3)\ H_3O^+"'] & Q \arrow[d, "SOCl_2"] \\ S & & R \arrow[ll, "H_2/Pd\text{-}BaSO_4", "quinoline"'] \end{tikzcd}$$

(a) 

(b) 

(c) 

(d) 

34. Given :

$E°_{Cr^{3+}/Cr} = -0.74$ V, $E°_{MnO_4^-/Mn^{2+}} = 1.51$ V

$E°_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33$ V, $E°_{Cl/Cl^-} = 1.36$ V

Based on the given data, strongest oxidising agent will be

(a) Cl^- (b) Cr^{3+} (c) Mn^{2+} (d) MnO_4^-

35. The equilibrium constant (K) for the reaction, $HA + B \rightleftharpoons BH^+ + A^-$ is 100. If the rate constant for the forward reaction is 10^5, then the rate constant for the reverse reaction will be

(a) 10^7 (b) 10^{-3} (c) 10^3 (d) 10^{-5}

36. A mixture of ethane (C_2H_6) and ethene (C_2H_4) occupies 40 L at 1.00 atm and 400 K. The mixture reacts completely with 130 g of O_2 to produce CO_2 and H_2O. Assuming ideal gas behaviour, the mole fraction of C_2H_4 in the mixture is

(a) 0.66 (b) 0.34 (c) 0.50 (d) 0.84

37. Two liquids X and Y form an ideal solution. The mixture has a vapour pressure of 400 mm at 300 K when mixed in the molar ratio of 1 : 1 and a vapour pressure of 350 mm when mixed in the molar ratio of 1 : 2 at the same temperature. The vapour pressures of the two pure liquids X and Y respectively are

(a) 250 mm, 550 mm (b) 350 mm, 450 mm
(c) 350 mm, 700 mm (d) 550 mm, 250 mm

38. ΔH and ΔS for the reaction,

$$Ag_2O_{(s)} \longrightarrow 2Ag_{(s)} + 1/2\ O_{2(g)}$$

are 30.56 kJ mol^{-1} and 66.00 J K^{-1} mol^{-1} respectively. The temperature at which the free energy change for the reaction will be zero is

(a) 463 K (b) 35440 K
(c) 20 K (d) 483 K

39. Determine the standard reduction potential for the half cell reaction, $Cl_2 + 2e^- \longrightarrow 2Cl^-$.

(Given : $Pt^{2+} + 2Cl^- \longrightarrow Pt + Cl_2$, $E°_{cell} = -0.15$ V
$Pt^{2+} + 2e^- \longrightarrow Pt$, $E° = 1.20$ V)

(a) 1.05 V (b) – 1.05 V
(c) – 1.35 V (d) 1.35 V

40. Among 2-chloropropanoic acid, 3-chloropropanoic acid, 2,2-dichloroacetic acid and propanoic acid, the K_a values will be in the order,

(a) 2,2-dichloroacetic acid > 2-chloropropanoic acid > 3-chloropropanoic acid > propanoic acid
(b) 3-chloropropanoic acid > 2-chloropropanoic acid > 2,2-dichloroacetic acid > propanoic acid
(c) 2,2-dichloroacetic acid > 3-chloropropanoic acid > 2-chloropropanoic acid > propanoic acid
(d) 2,2-dichloroacetic acid > propanoic acid > 2-chloropropanoic acid > 3-chloropropanoic acid

41. The vapour pressure of a pure liquid A is 40 mm Hg at 310 K. The vapour pressure of this liquid in a solution with liquid B is 35 mm Hg. Mole fraction of A in the solution is 0.8 then

(i) it is a non-ideal solution having negative deviation.
(ii) temperature of system is decreased.
(iii) $\Delta V_{mix} > 0$

Find the correct statement(s).

(a) Only (i) (b) Only (ii)
(c) Only (i) and (ii) (d) Only (ii) and (iii)

42. An organic compound whose empirical and molecular formulae are same, contains 20% carbon, 6.7% hydrogen, 46.7% nitrogen and the rest oxygen. On heating it yields ammonia, leaving a solid residue. The solid residue gives a violet colour with dilute solution of alkaline copper sulphate. The organic compound is

(a) NH_2COONH_4 (b) CH_3COONH_4
(c) NH_2NHCHO (d) NH_2CONH_2

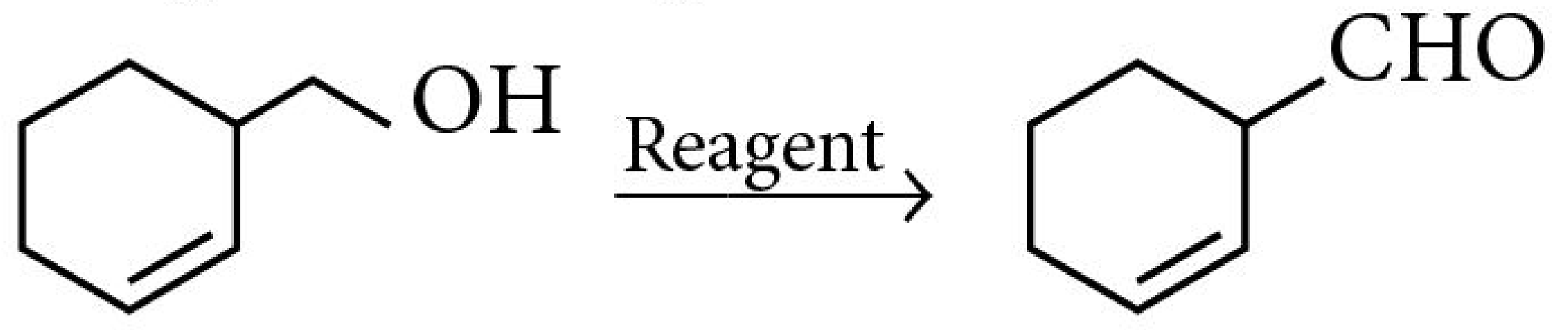
43. Formation of methyl t-butylether by the reaction of sodium t-butoxide and methylbromide involves

(a) elimination reaction
(b) electrophilic addition reaction
(c) nucleophilic addition reaction
(d) nucleophilic substitution reaction.

44. Which of the following is not correctly matched?

(a) $[Ni(CN)_4]^{2-}$: square planar, diamagnetic
(b) $[Ni(PPh_3)_4]^{2+}$: square planar, diamagnetic
(c) $[Ni(CO)_4]$: tetrahedral, paramagnetic
(d) $[NiCl_4]^{2-}$: tetrahedral, paramagnetic

45. Reagent for the given reaction will be

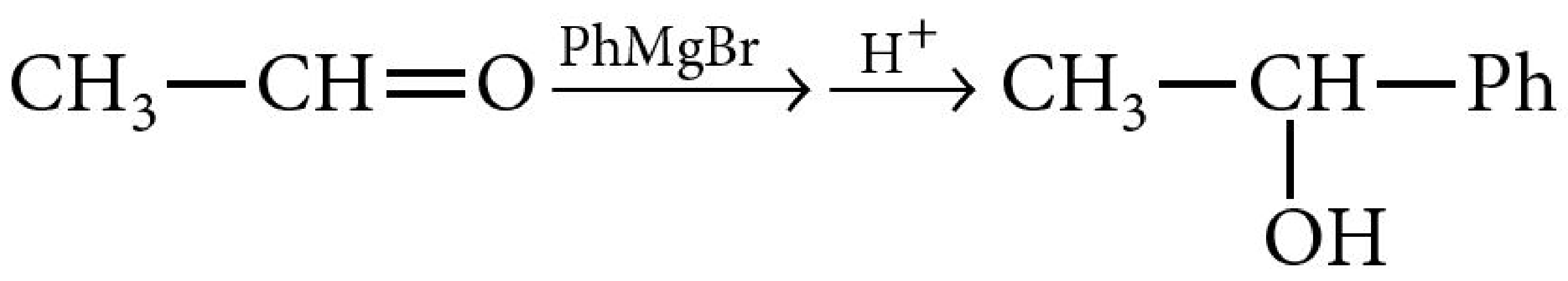


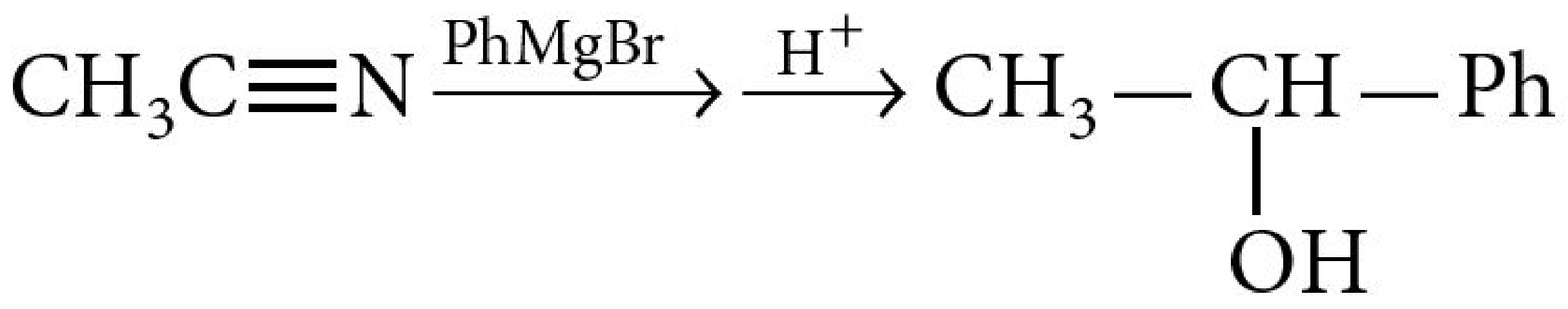
(a) hot acidic $KMnO_4$ (b) CrO_3, H^+
(c) CrO_3, pyridine, CH_2Cl_2
(d) dil. alkaline $KMnO_4$.

46. In which of the following reactions, the given product is incorrect?

(a) $Ph-MgBr \xrightarrow{O_2} \xrightarrow{H^+} Ph-OH$

(b) $CH_3-CH_2-MgBr \xrightarrow{CO_2} \xrightarrow{H^+} CH_3-CH_2-COOH$

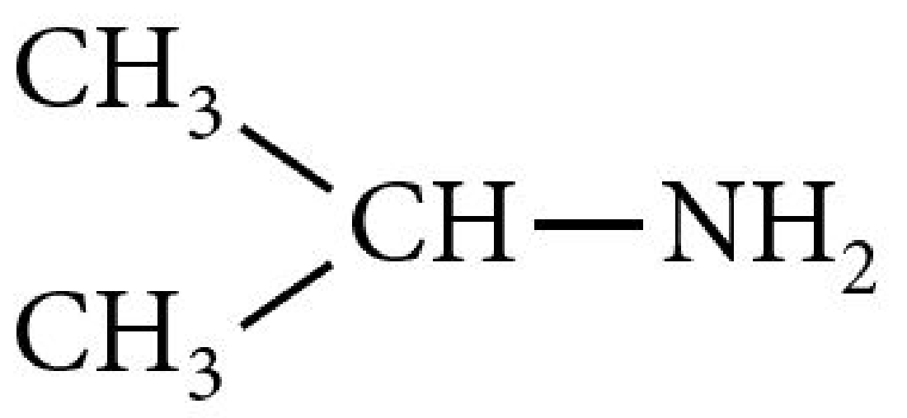
(c) 
$CH_3-CH=O \xrightarrow{PhMgBr} \xrightarrow{H^+} CH_3-\underset{\underset{OH}{|}}{CH}-Ph$

(d) 
$CH_3C\equiv N \xrightarrow{PhMgBr} \xrightarrow{H^+} CH_3-\underset{\underset{OH}{|}}{CH}-Ph$

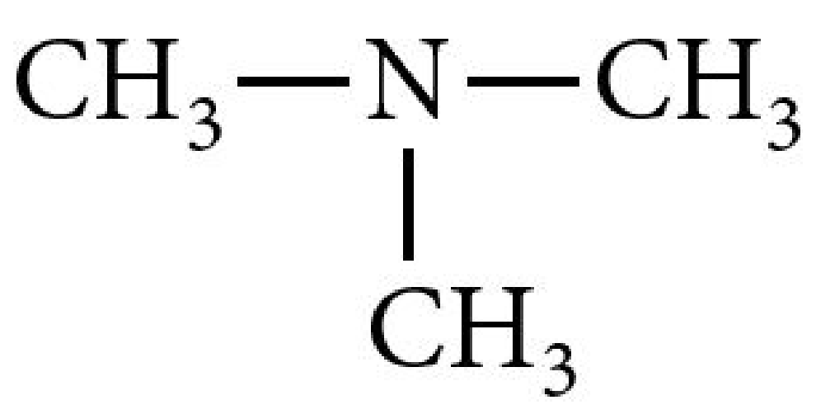
47. A gas expands from 3 dm^3 to 5 dm^3 against a constant pressure of 3 atm. The work done during expansion is used to heat 10 moles of water at 290 K. Calculate final temperature of water.
(Specific heat of water = 4.184 J $g^{-1}K^{-1}$)

(a) 290 K (b) 290.81 K
(c) 289.19 K (d) 289.52 K

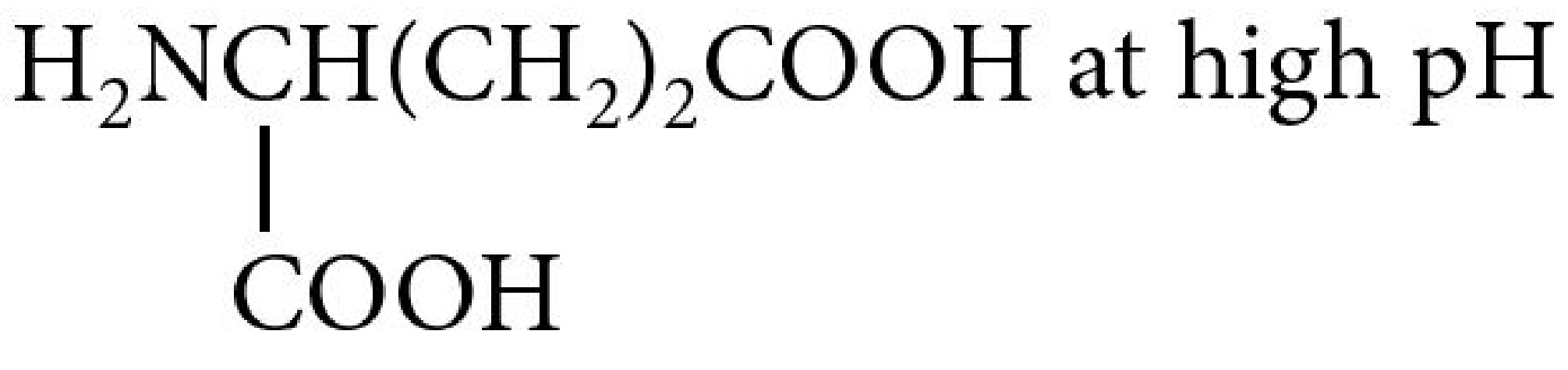
48. An organic compound, C_3H_9N (*A*), when treated with nitrous acid, gave an alcohol (*B*) and N_2 gas was evolved. (*A*) on warming with $CHCl_3$ and caustic potash gave (*C*) which on reduction gave isopropylmethyl amine. Predict the structure of (*A*).

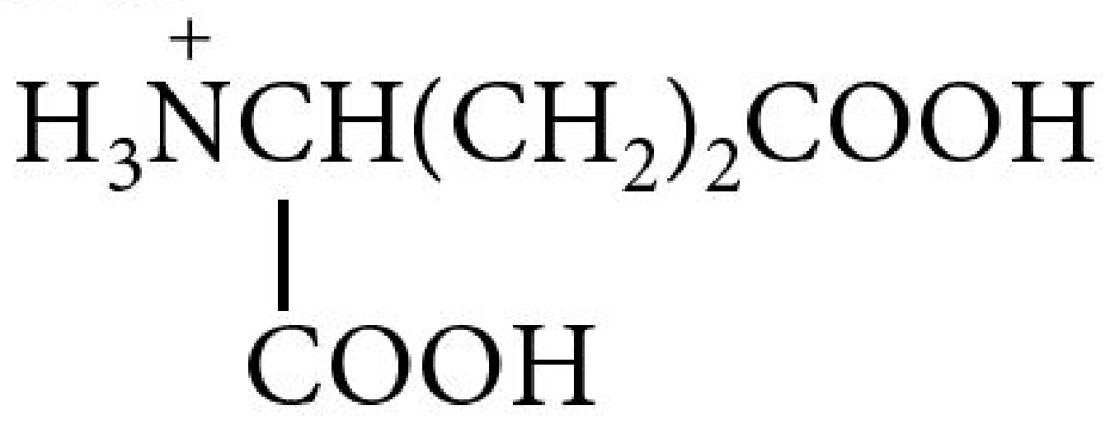
(a) 
$\begin{array}{l}CH_3\diagdown\\ \qquad\quad CH-NH_2\\ CH_3\diagup\end{array}$

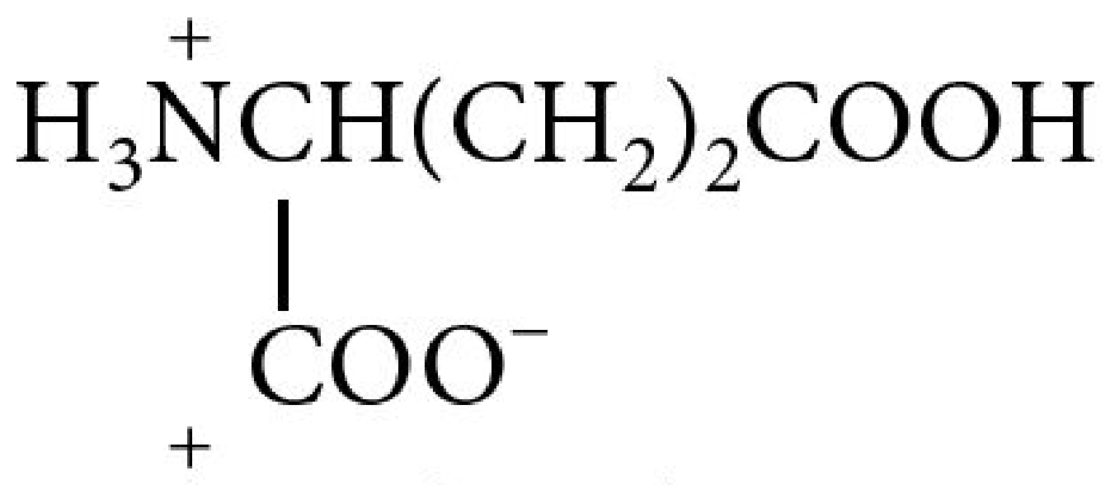
(b) $CH_3CH_2-NH-CH_3$

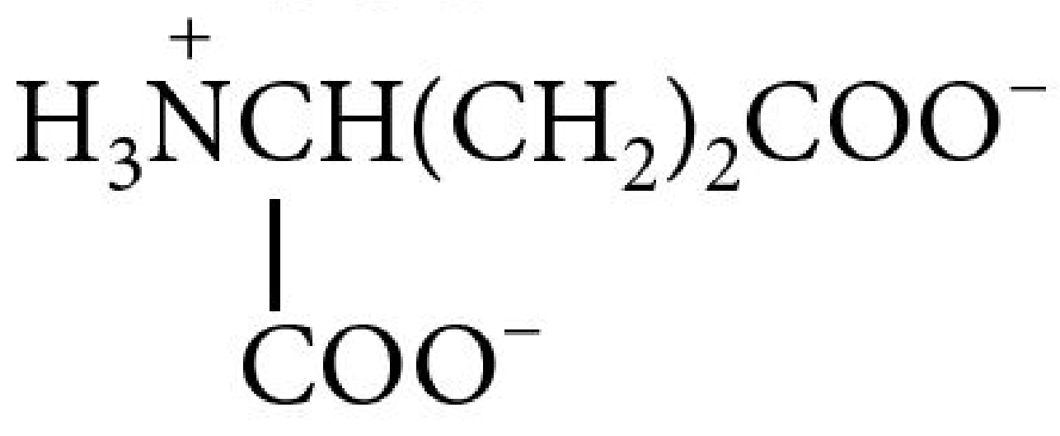
(c) 
$CH_3-\underset{\underset{CH_3}{|}}{N}-CH_3$

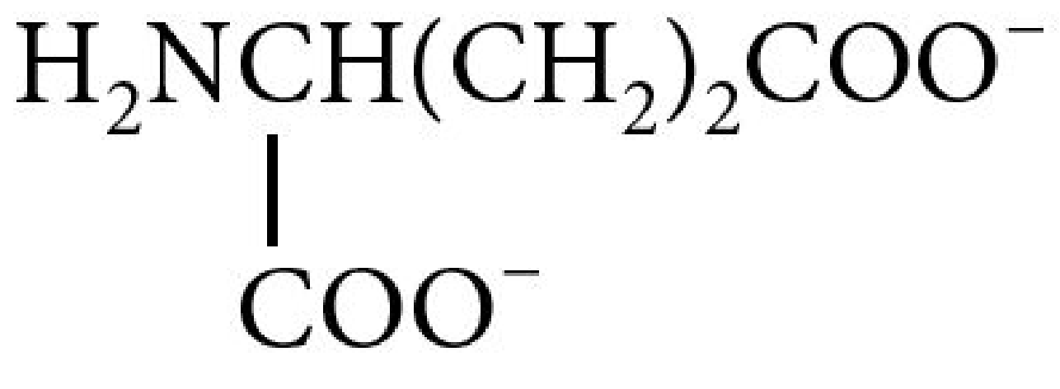
(d) $CH_3CH_2CH_2-NH_2$

49. The amino acid,  $H_2N\underset{\underset{COOH}{|}}{CH}(CH_2)_2COOH$ at high pH exists as

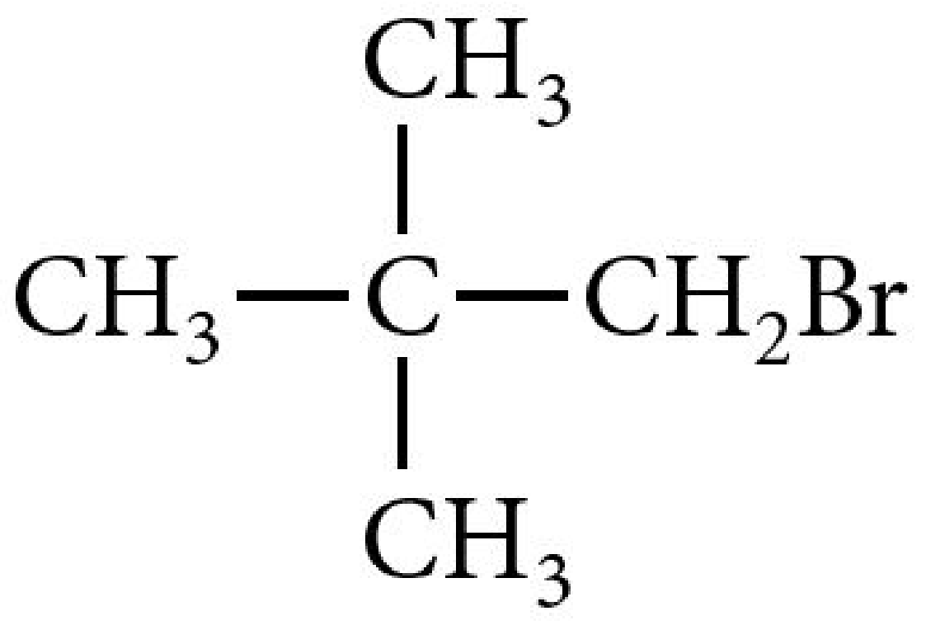
(a) 
$H_3\overset{+}{N}\underset{\underset{COOH}{|}}{CH}(CH_2)_2COOH$

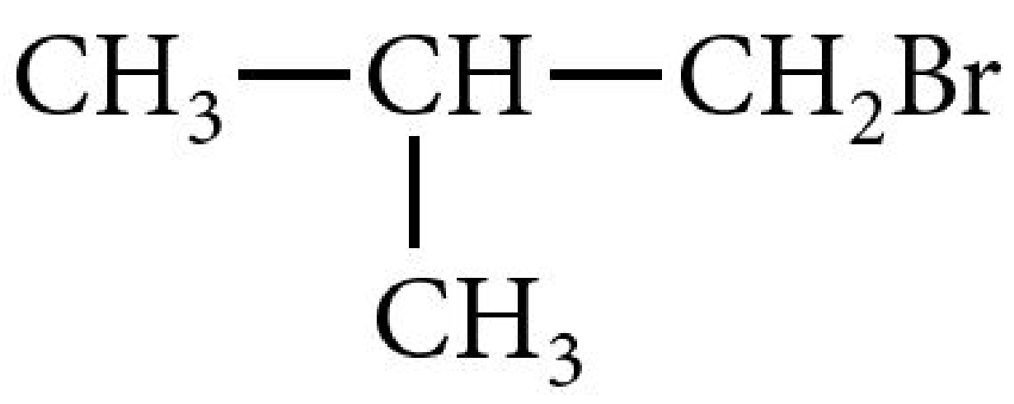
(b) 
$H_3\overset{+}{N}\underset{\underset{COO^-}{|}}{CH}(CH_2)_2COOH$

(c) 
$H_3\overset{+}{N}\underset{\underset{COO^-}{|}}{CH}(CH_2)_2COO^-$

(d) 
$H_2N\underset{\underset{COO^-}{|}}{CH}(CH_2)_2COO^-$

50. In S_N2 substitution reaction of the type,
$R-Br + Cl^- \xrightarrow{DMF} R-Cl + Br^-$
which one of the following has the highest relative rate?

(a) 
$CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_2Br$
(b) CH_3CH_2Br

(c) $CH_3CH_2CH_2Br$
(d) 
$CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2Br$

51. The electrons identified by quantum numbers *n* and *l*:

(1) $n = 4, l = 1$ (2) $n = 4, l = 0$
(3) $n = 3, l = 2$ (4) $n = 3, l = 1$

can be placed in order of increasing energy as

(a) (4) < (2) < (3) < (1) (b) (2) < (4) < (1) < (3)
(c) (1) < (3) < (2) < (4) (d) (3) < (4) < (2) < (1)

52. Which of the following isomeric heptanes can yield seven different monochlorinated products upon free radical chlorination?

(a) 3-Methylhexane
(b) 2,2-Dimethylpentane
(c) 2-Methylhexane
(d) 2,3-Dimethylpentane

53. Which reagent is not suitable for the following conversion?

$Ph-CH=O \xrightarrow{Reagent} Ph-COOH$

(a) Tollens' reagent (b) Fehling solution
(c) $K_2Cr_2O_7$, H^+ (d) Acidic $KMnO_4$

54. The decreasing order of reactivity of the following towards OH^- ions is

(I) *m*-Nitrobromobenzene
(II) 2,4,6-Trinitrobromobenzene
(III) *p*-Nitrobromobenzene
(IV) 2,4-Dinitrobromobenzene

(a) I > II > III > IV (b) II > IV > III > I
(c) IV > II > III > I (d) II > IV > I > III

55. In the Arrhenius equation for a certain reaction, the values of *A* and E_a (activation energy) are 4×10^{13} s^{-1} and 98.6 kJ mol^{-1} respectively. If the reaction is of first order, at what temperature will its half-life period be ten minutes?
(log 0.001155 = –2.9374 and log 4 = 0.6020)

(a) 323.56 K (b) 311.35 K
(c) 275.01 K (d) 510.05 K

56. pH of a saturated solution of magnesium hydroxide in water at 298 K is 10. The solubility of the hydroxide in water at 298 K is

(a) 5×10^{-5} mol L^{-1}
(b) 5×10^{-12} mol L^{-1}
(c) 1×10^{-4} mol L^{-1}
(d) 1×10^{-10} mol L^{-1}

57. IUPAC name of $BrCH_2(CONH_2)CHCOCH_2CH_3$ is

(a) 3-(bromoethyl)-3-oxopentanamide
(b) 2-(bromoethyl)-3-ketopentanamide
(c) 2-(bromoethyl)-3-oxopentanamide
(d) 2-(bromomethyl)-3-oxopentanamide.

58. Which of the following statements is incorrect?

(a) In $K_3[Fe(CN)_6]$, the ligand has satisfied only the secondary valency of ferric ion.
(b) In $K_3[Fe(CN)_6]$, the ligand has satisfied both primary and secondary valencies of ferric ion.
(c) In $K_4[Fe(CN)_6]$, the ligand has satisfied both primary and secondary valencies of ferrous ion.
(d) In $[Cu(NH_3)_4]SO_4$, the ligand has satisfied only the secondary valency of copper.

59. When $KMnO_4$ acts as an oxidising agent and ultimately forms MnO_4^{2-}, MnO_2, Mn_2O_3 and Mn^{2+}, then the number of electrons transferred in each case respectively is

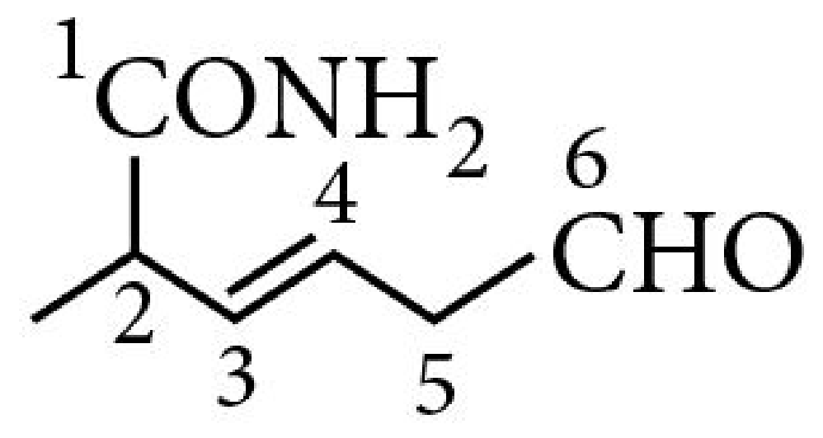
(a) 4, 3, 1, 5
(b) 1, 5, 3, 7
(c) 1, 3, 4, 5
(d) 3, 5, 7, 1

60. Increasing order of ionic size for the ions, F^-, O^{2-}, Na^+, Al^{3+} is

(a) $O^{2-} < F^- < Na^+ < Al^{3+}$
(b) $Al^{3+} < Na^+ < F^- < O^{2-}$
(c) $O^{2-} < Na^+ < F^- < Al^{3+}$
(d) $Al^{3+} < F^- < Na^+ < O^{2-}$

SOLUTIONS

1. (c) :



2-Methyl-6-oxohex-3-enamide

2. (c) : $K_4[Fe(CN)_6] \rightleftharpoons 4K^+ + [Fe(CN)_6]^{4-}$

Potassium hexacyanoferrate(II) gives a total of 5 ions in aqueous solution thus, it has the highest molar conductivity whereas other complexes will give lesser number of ions.

3. (b): ^-OR is the strongest base since R (alkyl) group is an electron releasing group which increases electron density on oxygen.

4. (c) : The value of van't Hoff factor for the given solutions will be the same, *i.e.*, $i_A = i_B = i_C$ due to complete dissociation of NaCl (strong electrolyte) in dilute solutions. On complete dissociation value of i for NaCl is 2.

5. (c) : $\Delta_f H = (B.E.)_{\text{reactants}} - (B.E.)_{\text{products}}$

But all the species must be in gaseous state, so in product $[H_2O_{(l)} \longrightarrow H_2O_{(g)}]\ \Delta H_{\text{vap}}$ must be added.

Hence for the reaction, $H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)}$

$$\Delta_f H = \left[(B.E.)_{H-H} + \frac{1}{2}(B.E.)_{O=O}\right] - [\Delta H_{\text{vap}} + 2(B.E.)_{O-H}]$$

$$= x_1 + \frac{x_2}{2} - [x_4 + 2x_3] \Rightarrow x_1 + \frac{x_2}{2} - x_4 - 2x_3$$

6. (c) : $BOH \rightleftharpoons B^+ + \bar{O}H;\quad (K_b = 2.5 \times 10^{-6})$

$$H^+ + \bar{O}H \rightleftharpoons H_2O;\ \left(K = \frac{1}{K_w}\right)$$

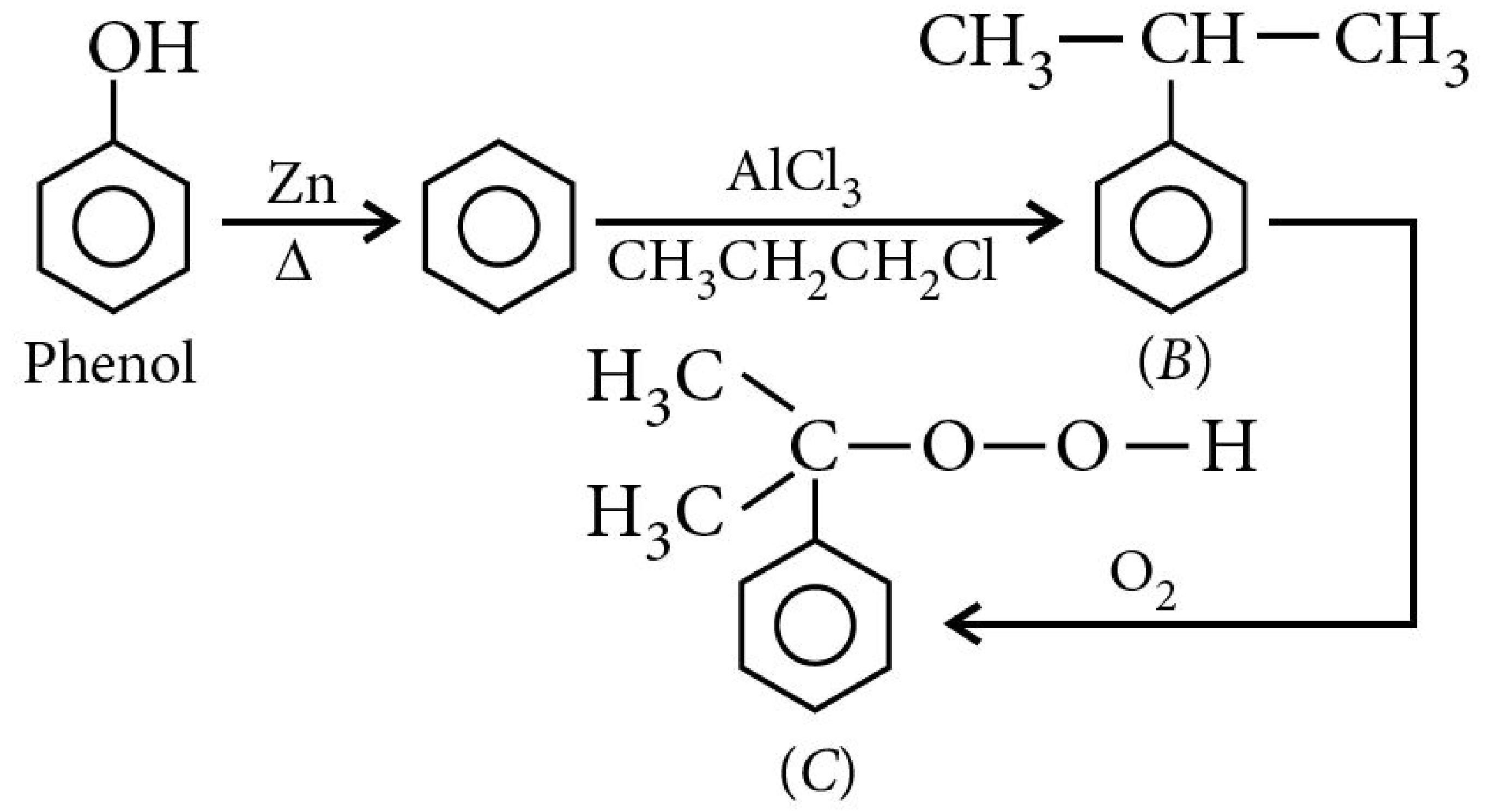
$$BOH + H^+ \rightleftharpoons B^+ + H_2O;\ K' = ?$$

$$\therefore \quad K' = K_b \times \frac{1}{K_w} = \frac{2.5\times10^{-6}}{10^{-14}} = 2.5 \times 10^{8}$$

7. (b): $CH \equiv CH + HCl \longrightarrow CH_2 = CHCl \xrightarrow{HCl} CH_3—CHCl_2$

8. (a)

9. (b):



10. (b): $NH_4Cl \rightleftharpoons NH_4^+ + Cl^-$ ...(i)

$NaCl \rightleftharpoons Na^+ + Cl^-$ ...(ii)

$NaOH \rightleftharpoons Na^+ + OH^-$ ...(iii)

$NH_4OH \rightleftharpoons NH_4^+ + OH^-$ ...(iv)

Applying (i) + (iii) – (ii) to get the equation (iv),

$$\Lambda^\circ_{m(NH_4Cl)} + \Lambda^\circ_{m(NaOH)} - \Lambda^\circ_{m(NaCl)} = \Lambda^\circ_{m(NH_4OH)}$$

11. (d)

12. (a) : $E_n = \dfrac{-2.18\times10^{-18}}{n^2}$ J atom^{-1}

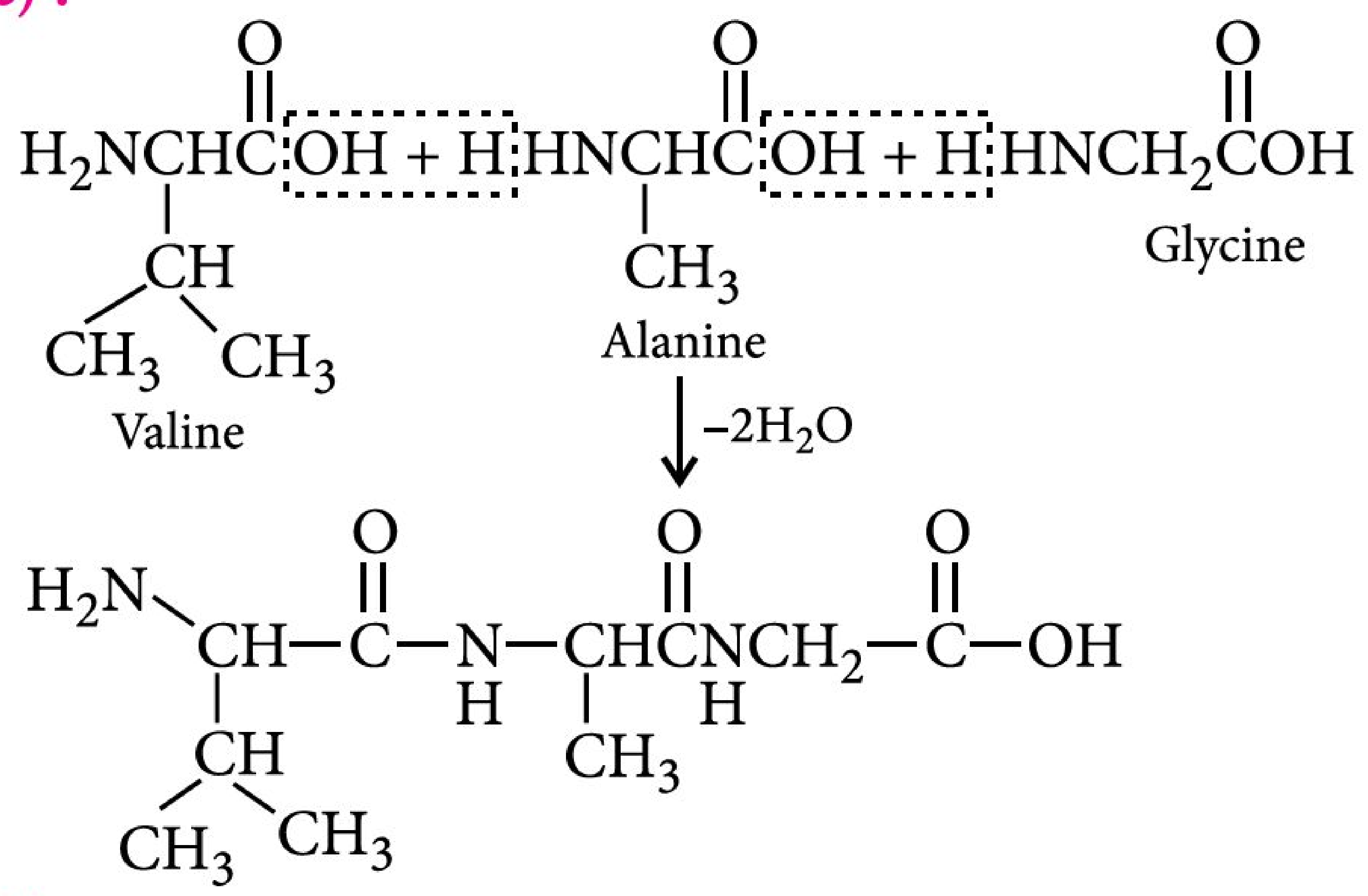
$$\Delta E = E_4 - E_1 = -2.18 \times 10^{-18}\left(\frac{1}{4^2} - \frac{1}{1^2}\right)$$

$$= -2.18 \times 10^{-18}(-0.9375) \Rightarrow 2.043 \times 10^{-18} \text{ J atom}^{-1}$$

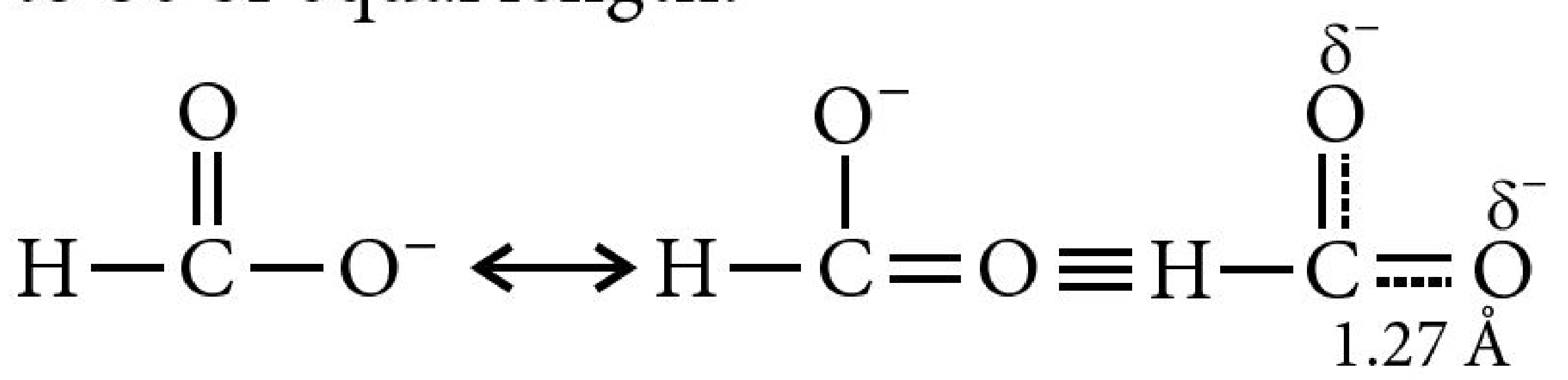
Also, $\Delta E = h\nu$

$$\therefore \quad \nu = \frac{\Delta E}{h} = \frac{2.043\times10^{-18}}{6.626\times10^{-34}} = 3.08 \times 10^{15}\ s^{-1}$$

13. (c) :



14. (b): As the anion $HCOO^-$ has two resonating structures, so the carbon-oxygen bonds are found to be of equal length.



15. (b): The colour of CrO_3 (d^0 configuration) is due to charge transfer from ligand (oxygen) to metal (chromium) and not due to *d*-*d* transition.

16. (d): Dissolving salt in a solvent or liquid lowers the vapour pressure.

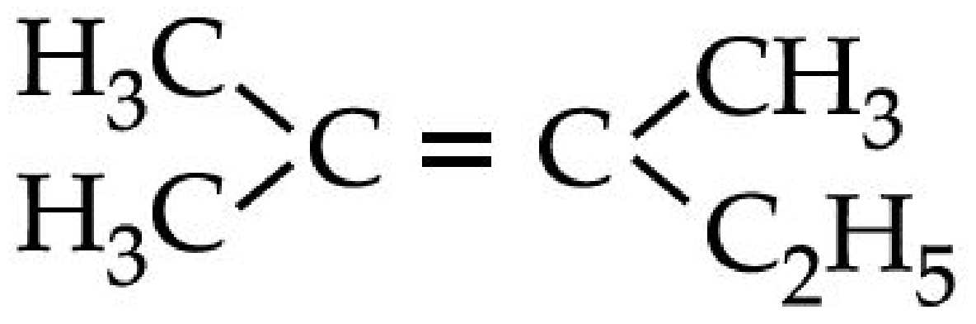
17. (b): Lactose on hydrolysis with acetic acid gives glucose and galactose.

18. (a) : $\underset{\text{Weak field ligand}}{SCN^-} < OH^- < NCS^- < \underset{\text{Strong field ligand}}{CO}$

19. (b) : (i) represents an electron in 3*s* orbital.
(ii) is not possible as value of *l* varies from 0 to $(n - 1)$.
(iii) represents an electron in 4*f* orbital.
(iv) is not possible as value of *m* varies from $-l$ to $+l$.
(v) is not possible as value of *m* varies from $-l$ to $+l$, it can never be greater than *l*.

20. (b): Zn-Hg and conc. HCl reduces aldehydes and ketones but carboxylic acid group remains unaffected.

21. (d):



$(H_3C)_2C=C(CH_3)(C_2H_5)$ will not show geometrical isomerism due to the presence of similar alkyl groups on the same carbon atom of double bond.

22. (b):

$$Ag + I^- \longrightarrow AgI + e^-,\ E^\circ_1 = 0.152\ V$$
$$Ag^+ + e^- \longrightarrow Ag,\ E^\circ_2 = 0.800\ V$$
$$\overline{Ag^+ + I^- \longrightarrow AgI,\ E^\circ = 0.952\ V}$$

At equilibrium, $E^\circ = \dfrac{2.303RT}{F}\log K_c$

But $K_c = \dfrac{[AgI]}{[Ag^+][I^-]} = \dfrac{1}{K_{sp}}$

$\therefore\quad 0.952 = -\dfrac{2.303RT}{F}\log K_{sp} = -0.059\log K_{sp}$

or $\quad \log K_{sp} = -16.13$

23. (c) : Molarity of glucose in blood

$$= \frac{\text{No. of moles of glucose}}{\text{Volume of blood (in L)}}$$

$$= \frac{\text{Wt. of glucose}}{\text{Mol. wt. of glucose} \times \text{Volume of blood (in L)}}$$

[Mol. mass of glucose = 180 g/mol]

$$= \frac{0.9\ g}{180\ g/mol \times 1\ L} = 5 \times 10^{-3}\ mol\ L^{-1} = 0.005\ M$$

24. (a) : If $\Delta_o < P$, then fourth electron will go to higher energy, e_g orbital. Hence, the configuration becomes $t_{2g}^3\, e_g^1$.

25. (d): Energy required for the removal of second electron from He-atom

$$= +13.6\frac{Z^2}{n^2} = 13.6 \times \frac{2^2}{1^2} = 54.4\ eV$$

Hence, the total energy required for the removal of both the electrons = 24.6 + 54.4 = 79.0 eV

26. (b): For the first order reaction,

$$k = \frac{2.303}{t}\log\frac{[A]_0}{[A]_t}$$

If $[A]_0 = a,\ [A]_t = a - \dfrac{a \times 15}{100} = 0.85a,\ t = 20\,\text{min}$

$$k = \frac{2.303}{20}\log\frac{a}{0.85a} = \frac{2.303}{20} \times 0.0706$$

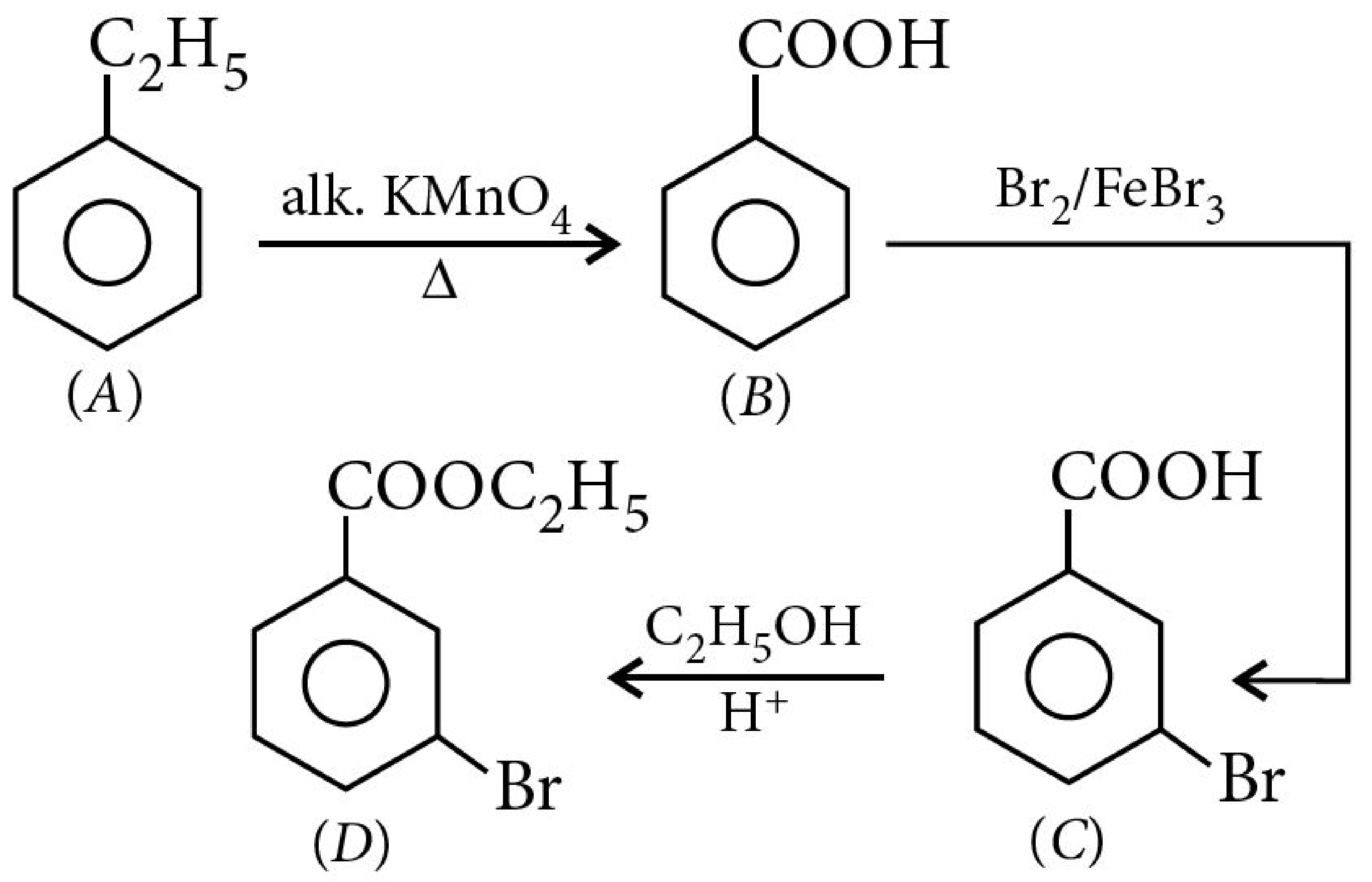
$= 8.13 \times 10^{-3}\ min^{-1}$

In second case, if $[A]0 = a$, $[A]_t = a - \dfrac{a \times 60}{100} = 0.40a$ and time, t = ?

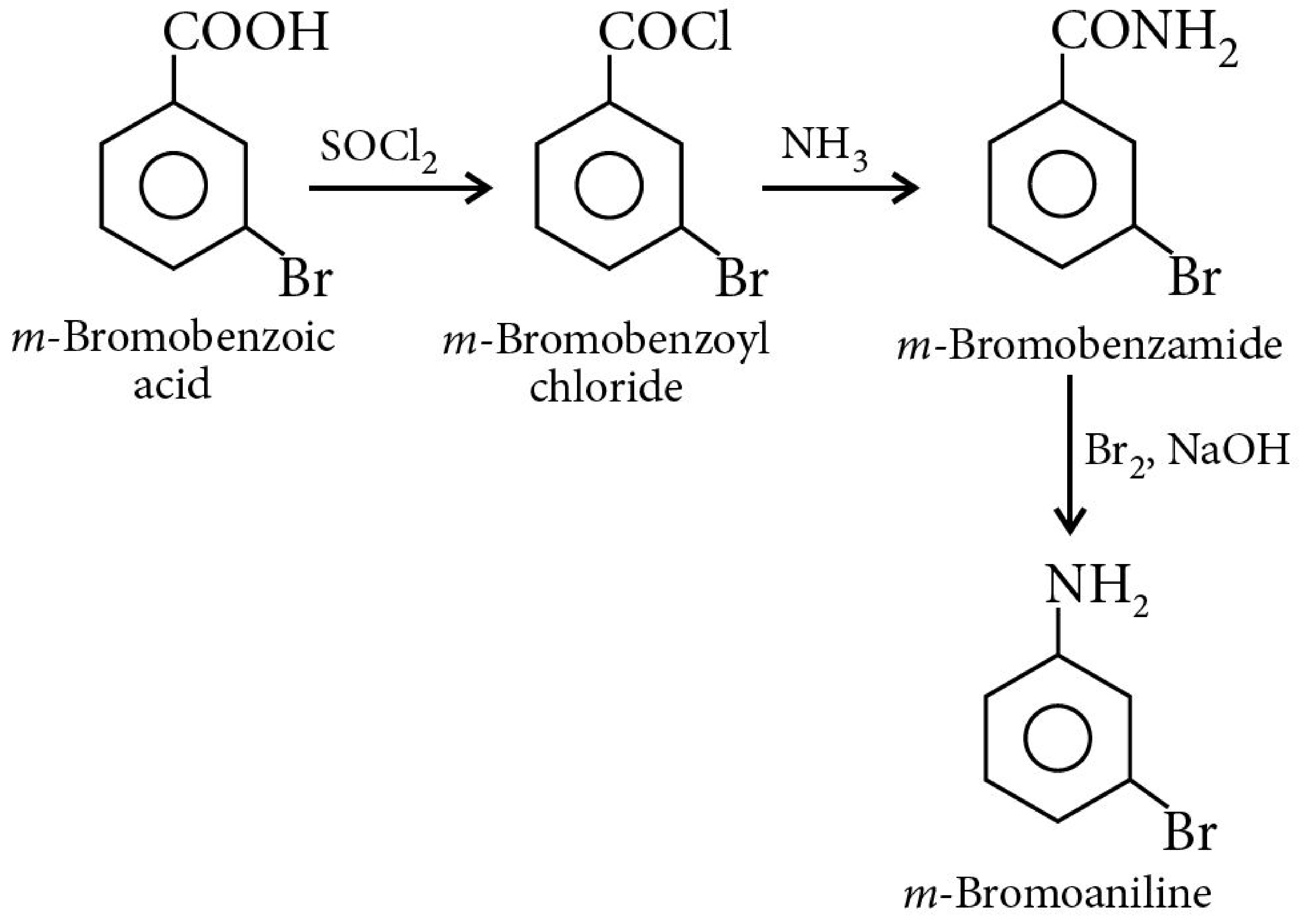
Now, $t = \dfrac{2.303}{k}\log\dfrac{[A]_0}{[A]_t} = \dfrac{2.303}{8.13 \times 10^{-3}}\log\dfrac{a}{0.40a}$

$$= \frac{2.303}{8.13 \times 10^{-3}} \times 0.3979 = 112.7\ min$$

27. (d):

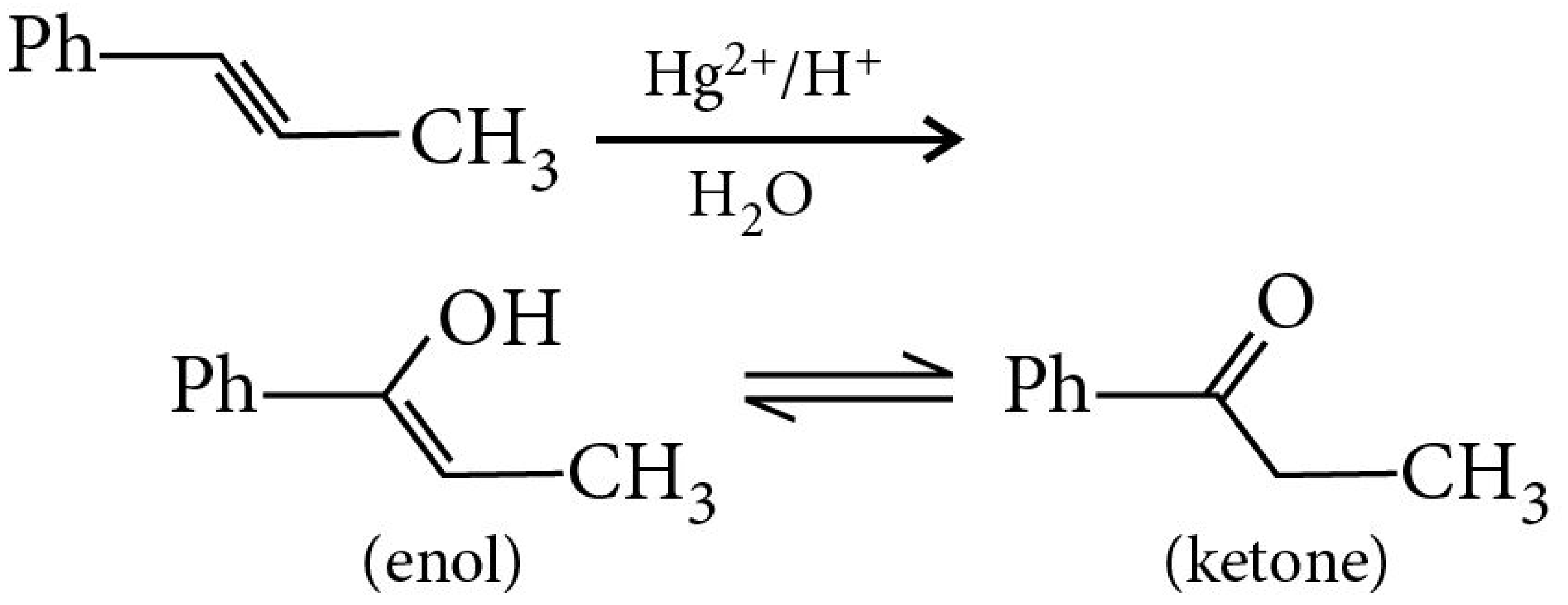


28. (c) :

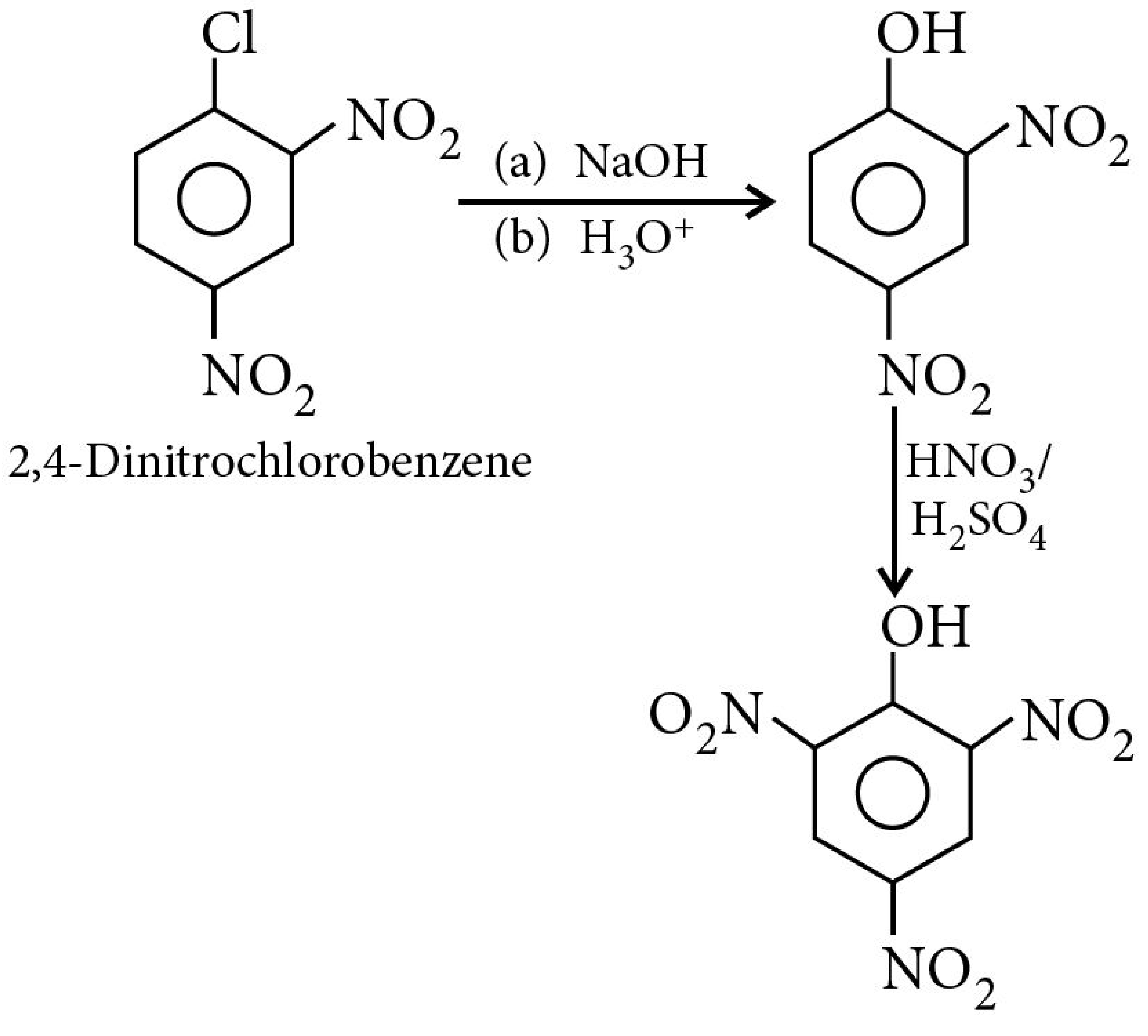

COOH
SOCl$_2$
COCl
NH$_3$
CONH$_2$
Br
Br
Br
m-Bromobenzoic acid
m-Bromobenzoyl chloride
m-Bromobenzamide
Br$_2$, NaOH
NH$_2$
Br
m-Bromoaniline

29. (d): A compound is soluble if hydration enthalpy (released) is greater than lattice enthalpy.

30. (a) :


Ph
CH$_3$
Hg^{2+}/H$^+$
H$_2$O
OH
Ph
CH$_3$
O
Ph
CH$_3$
(enol)
(ketone)

31. (a) : Path I is feasible since –OH group after I (a) and I (b) activate the benzene ring for nitration. –Cl and two —NO$_2$ groups deactivate the ring in path II hence, nitration is not possible.

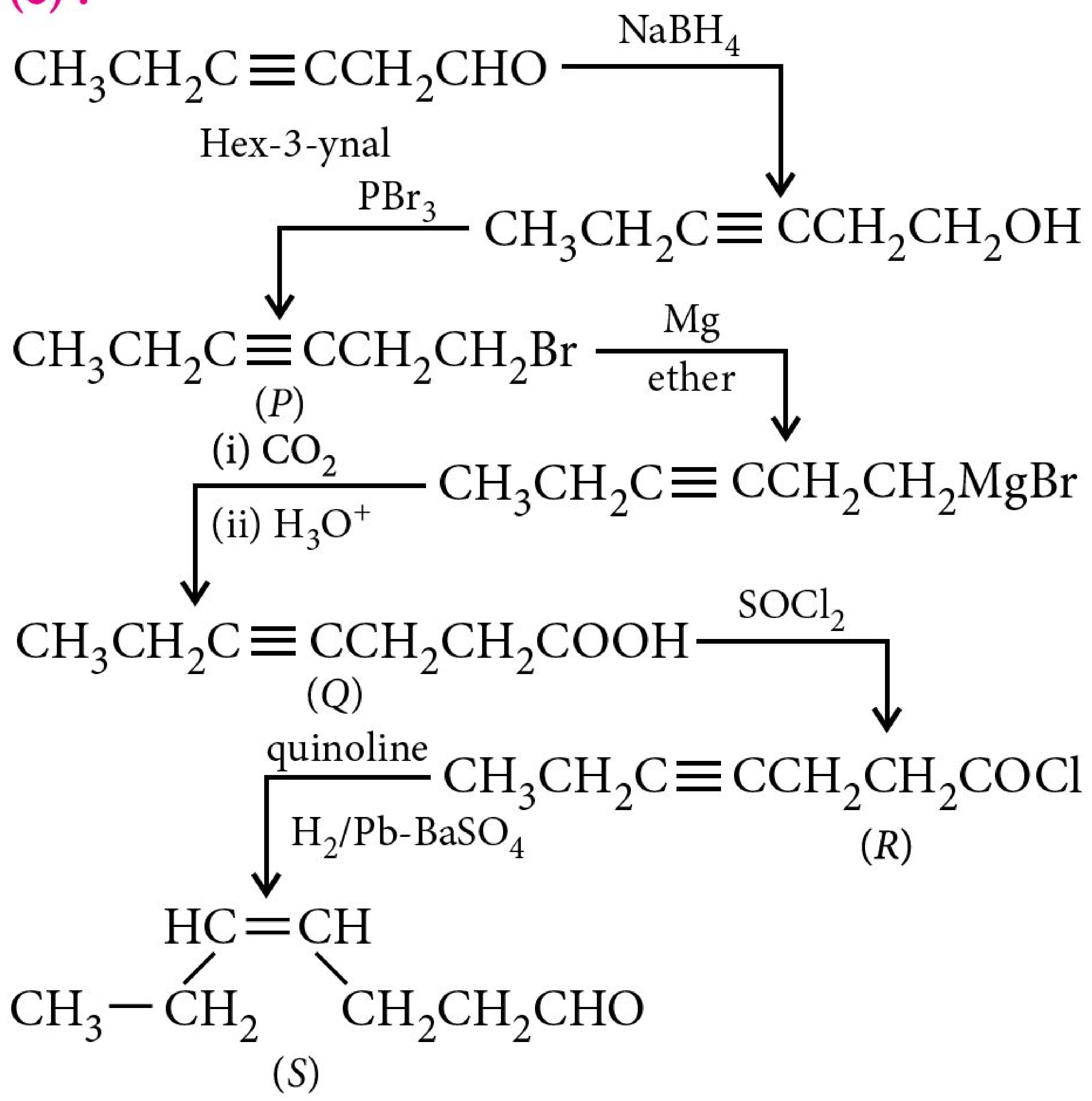

Cl
NO$_2$
NO$_2$
(a) NaOH
(b) H$_3$O$^+$
OH
NO$_2$
NO$_2$
2,4-Dinitrochlorobenzene
HNO$_3$/ H$_2$SO$_4$
OH
O$_2$N
NO$_2$
NO$_2$

Picric acid

In path I, due to —NO$_2$ group C—Cl bond weakens which makes nucleophilic substitution reaction possible. Also —NO$_2$ (deactivating group) prevents oxidation of 2,4-dinitrophenol when further nitrated.

32. (b) : The value of equilibrium constant of a reaction depends only on temperature and does not depend upon concentration, pressure or presence of catalyst.

33. (c) :


CH$_3$CH$_2$C≡CCH$_2$CHO
Hex-3-ynal
NaBH$_4$
CH$_3$CH$_2$C≡CCH$_2$CH$_2$OH
PBr$_3$
CH$_3$CH$_2$C≡CCH$_2$CH$_2$Br
(*P*)
Mg ether
CH$_3$CH$_2$C≡CCH$_2$CH$_2$MgBr
(i) CO$_2$
(ii) H$_3$O$^+$
CH$_3$CH$_2$C≡CCH$_2$CH$_2$COOH
(*Q*)
SOCl$_2$
CH$_3$CH$_2$C≡CCH$_2$CH$_2$COCl
(*R*)
quinoline
H$_2$/Pb-BaSO$_4$
HC=CH
CH$_3$—CH$_2$
CH$_2$CH$_2$CHO
(*S*)

34. (d): MnO_4^- is the strongest oxidising agent because it has the highest reduction potential value.

35. (c) : $HA + B \rightleftharpoons BH^+ + A^-$; $K = 100$

$$K_f = 10^5,\ K_b = ?,\ K_b = \frac{K_f}{K} = \frac{10^5}{100} = 10^3$$

36. (b): For a gaseous mixture of C_2H_6 and C_2H_4,

$$PV = nRT$$

∴ $1 \times 40 = n \times 0.082 \times 400 \Rightarrow n = 1.2195$

∴ Total moles of C_2H_6 and C_2H_4 = 1.2195

Let number of moles of C_2H_6 and C_2H_4 be *a* and *b* respectively.

$$a + b = 1.2195 \qquad \text{...(i)}$$

$$C_2H_6 + 7/2O_2 \longrightarrow 2CO_2 + 3H_2O$$

$$C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O$$

∴ Number of moles of O_2 needed for complete reaction of the mixture

$$= \frac{7a}{2} + 3b = \frac{130}{32} \qquad \text{...(ii)}$$

Solving eqs. (i) and (ii), we get, $a = 0.808$; $b = 0.4115$

∴ Mole fraction of $C_2H_6 = 0.808/1.2195 = 0.66$

and mole fraction of $C_2H_4 = \dfrac{0.4115}{1.2195} = 0.34$

37. (d): $n_X = n_Y = 1$ or $\dfrac{n_X}{n_Y} = 1$

$$x_X = \frac{1}{1+1} = \frac{1}{2},\ x_Y = \frac{1}{1+1} = \frac{1}{2}$$

$$P = p_X^\circ \times x_X + p_Y^\circ \times x_Y = 400 \text{ mm}$$

or $$\frac{1}{2}p_X^\circ + \frac{1}{2}p_Y^\circ = 400 \text{ mm} \qquad \text{...(i)}$$

When $\frac{n'_X}{n'_Y}=\frac{1}{2}$ at the same temperature,

$x'_X=\frac{1}{3}$ and $x'_Y=\frac{2}{3}$

$\therefore\quad P'=p^\circ_X\times x'_X+p^\circ_Y\times x'_Y=350$ mm

or $\quad \frac{1}{3}p^\circ_X+\frac{2}{3}p^\circ_Y=350$ mm ...(ii)

Solving equations (i) and (ii), we get, $p^\circ_X=550$ mm, $p^\circ_Y=250$ mm

38. (a) : According to Gibbs'-Helmholtz equation,

$$\Delta G=\Delta H-T\Delta S$$

At equilibrium, $\Delta G=0$

$0=\Delta H-T\Delta S$ or $\Delta H=T\Delta S$ or $T=\frac{\Delta H}{\Delta S}$

Here, $\Delta H=30.56\text{ kJ mol}^{-1}=30560\text{ J mol}^{-1}$

$\Delta S=66.00\text{ J K}^{-1}\text{ mol}^{-1}$

$\therefore\quad T=\frac{30560}{66}=463\text{ K}$

39. (d): $Pt+Cl_2\longrightarrow Pt^{2+}+2Cl^-;\ E^\circ_1=0.15\text{ V}$ ...(i)

$\Delta G^\circ=-nFE^\circ_{cell}\Rightarrow\Delta G^\circ_1=-2F(0.15)$

$Pt^{2+}+2e^-\longrightarrow Pt;\qquad E^\circ_2=1.20\text{ V}$ ...(ii)

$\Delta G^\circ_2=-2F(1.20)$

Adding equations (i) and (ii),

$Cl_2+2e^-\longrightarrow 2Cl^-$

Let standard reduction potential for this reaction be E°_{cell}.

$\Delta G^\circ=-nFE^\circ_{cell}=\Delta G^\circ_1+\Delta G^\circ_2$

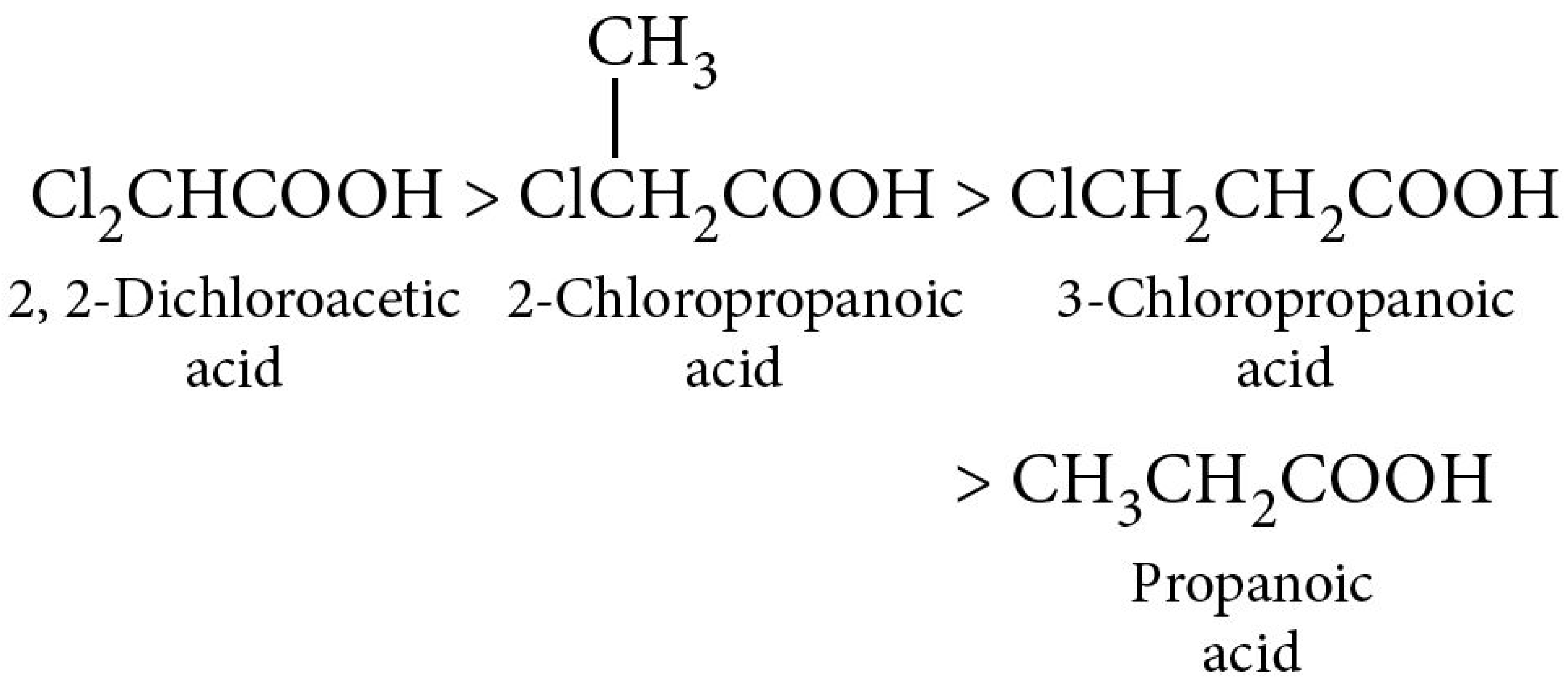
$-2\times FE^\circ_{cell}=-2F(0.15)-2F(1.20)$

$E^\circ_{cell}=0.15+1.20=1.35\text{ V}$

40. (a) : Acidic strength ∝ K_a value

Due to $-I$ effect of –Cl group, chloropropanoic acid is stronger acid than propanoic acid. Further, greater the number of electron withdrawing substituents, greater will be the acidic strength.

Inductive effect decreases rapidly with distance and so is the acidic strength. Hence, the correct order of acidic strength (or K_a values) will be



$$\underset{\text{2, 2-Dichloroacetic acid}}{Cl_2CHCOOH}>\underset{\text{2-Chloropropanoic acid}}{ClC\overset{CH_3}{|}H_2COOH}>\underset{\text{3-Chloropropanoic acid}}{ClCH_2CH_2COOH}>\underset{\text{Propanoic acid}}{CH_3CH_2COOH}$$

41. (d): $P_A=40\times0.8=32$ mm (*i.e.*, < 35 mm)

$\therefore$ The solution shows positive deviation.

42. (d) :

Element	%	Atomic mass	Relative no. of atoms	Simplest ratio
C	20%	12	1.66	1
H	6.7%	1	6.7	4
N	46.7%	14	3.33	2
O	26.6%	16	1.66	1

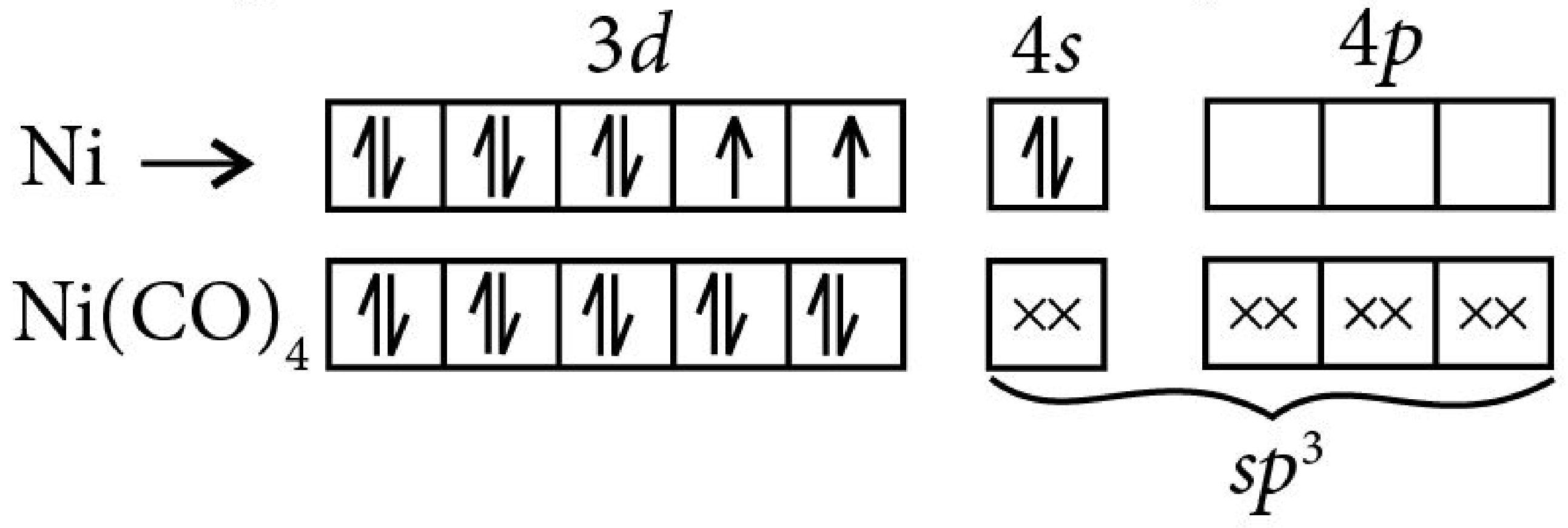
Empirical formula = Molecular formula

$= CH_4N_2O$ or NH_2CONH_2

$$NH_2CONH_2\xrightarrow{\Delta}NH_3+HCNO$$

43. (d)

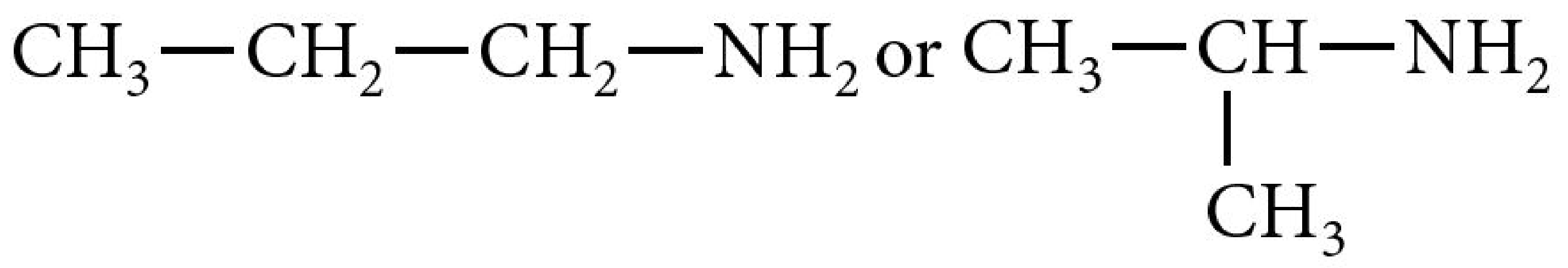
44. (c) : $Ni(CO)_4$ is a tetrahedral complex and is diamagnetic due to absence of unpaired electrons.



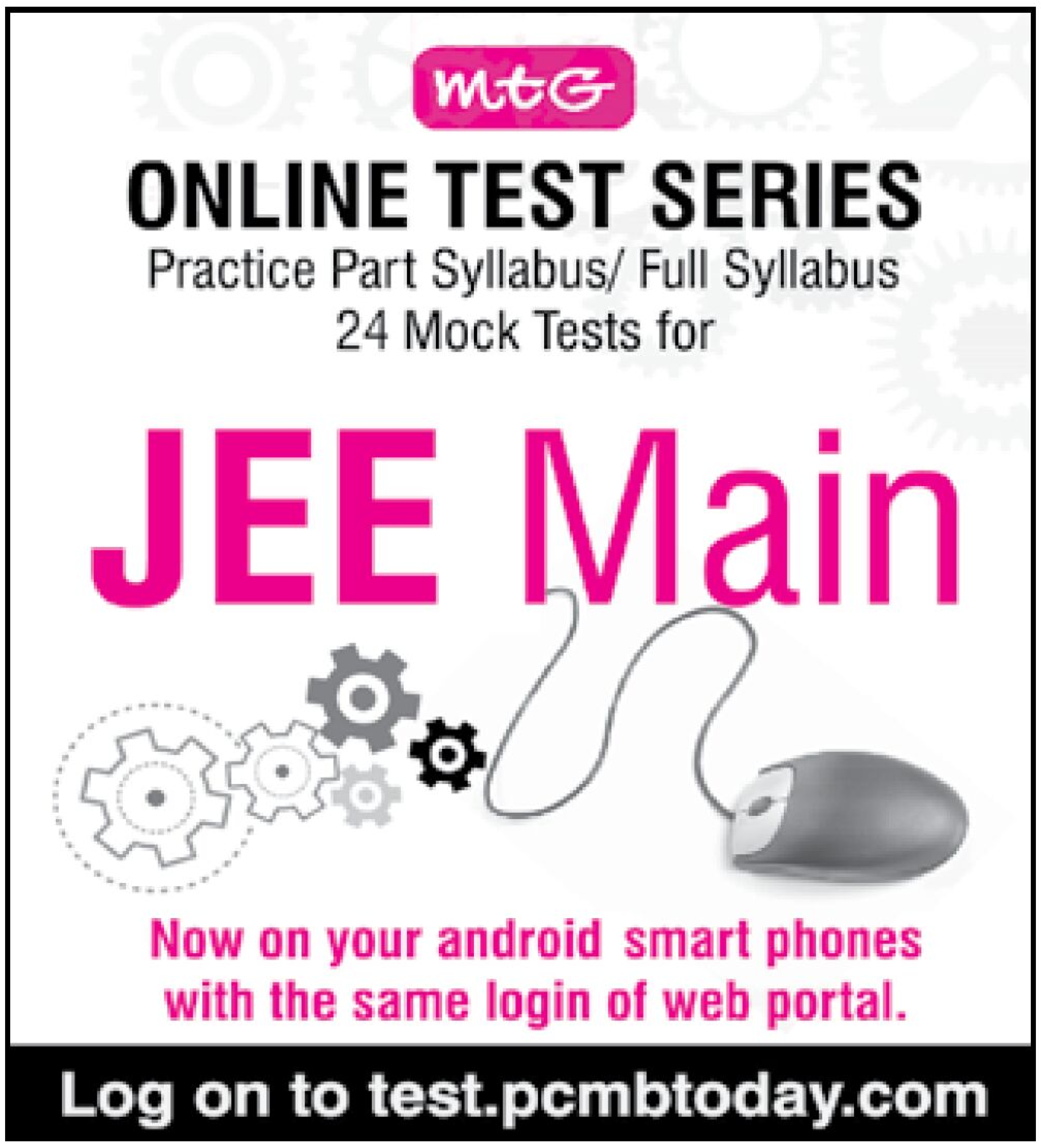
45. (c) : Mild oxidising agents like PCC can oxidise only alcohols into carbonyl compounds.

46. (d) **47. (b)**

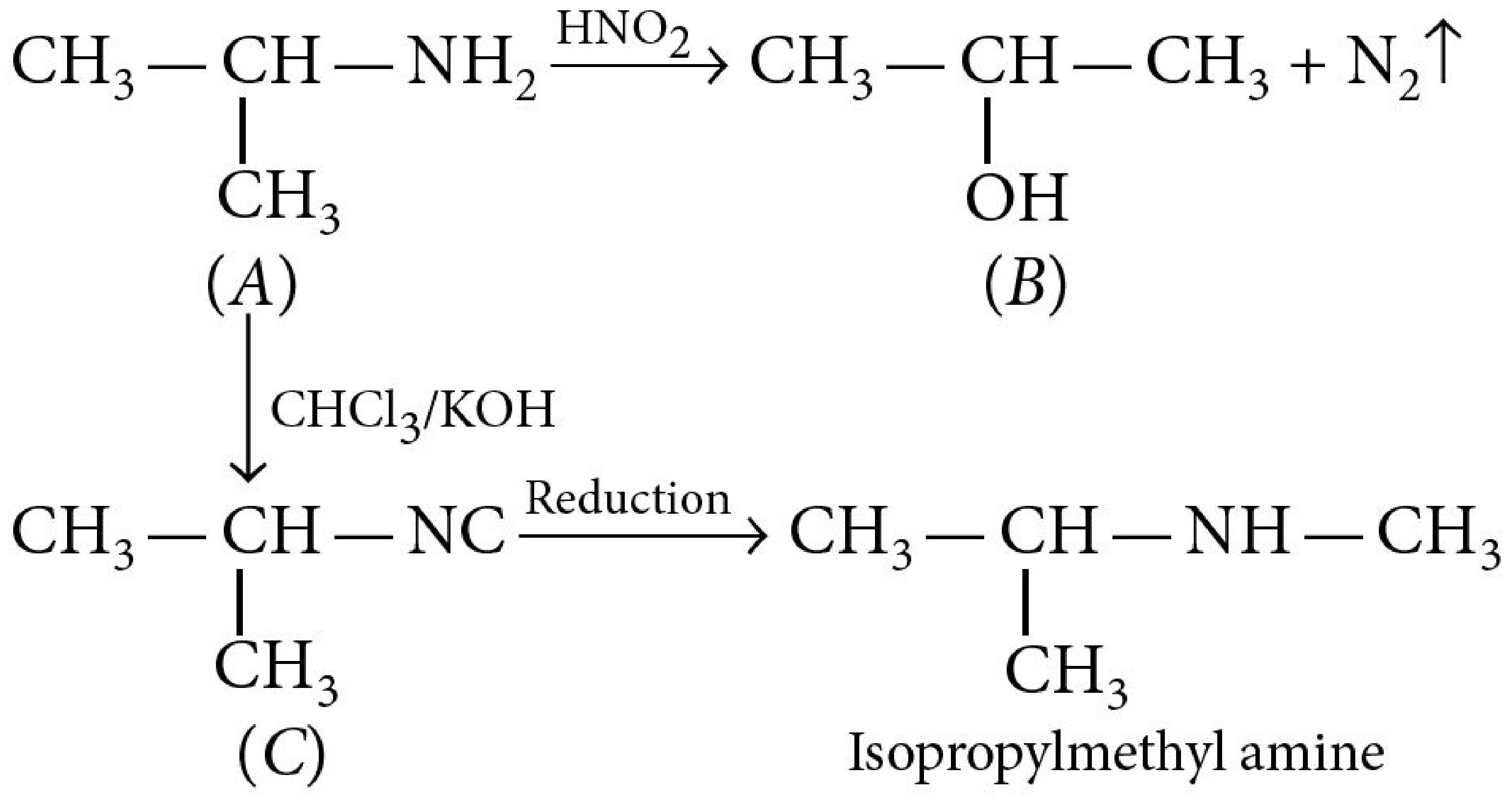
48. (a) : As '*A*' gives an alcohol on treatment with nitrous acid thus, it should be primary amine. C_3H_9N has two possible structures with $-NH_2$ group.



$$CH_3-CH_2-CH_2-NH_2 \text{ or } CH_3-\underset{\underset{CH_3}{|}}{CH}-NH_2$$


mtG
ONLINE TEST SERIES
Practice Part Syllabus/ Full Syllabus
24 Mock Tests for
JEE Main
Now on your android smart phones
with the same login of web portal.
Log on to test.pcmbtoday.com

As it gives isopropylmethyl amine thus, it should be isopropyl amine not *n*-propyl amine.



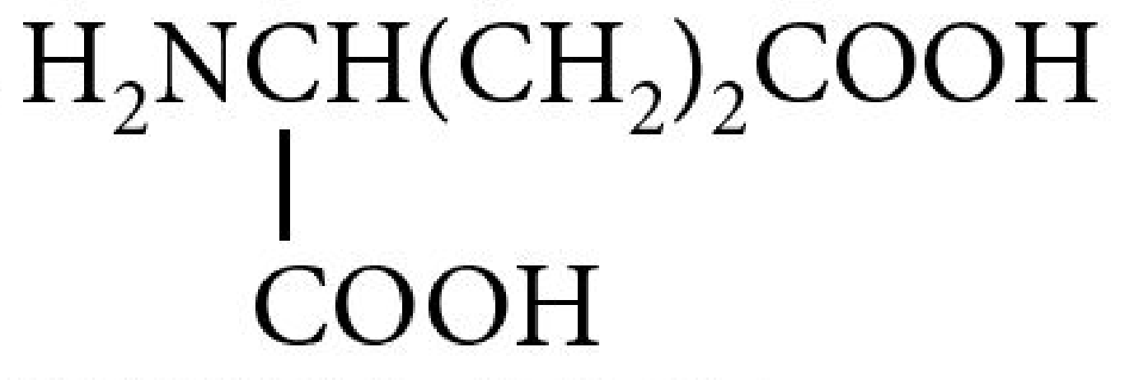
$$\underset{(A)}{CH_3-\underset{\underset{\displaystyle CH_3}{|}}{CH}-NH_2} \xrightarrow{HNO_2} \underset{(B)}{CH_3-\underset{\underset{\displaystyle OH}{|}}{CH}-CH_3} + N_2\uparrow$$

$$\Big\downarrow CHCl_3/KOH$$

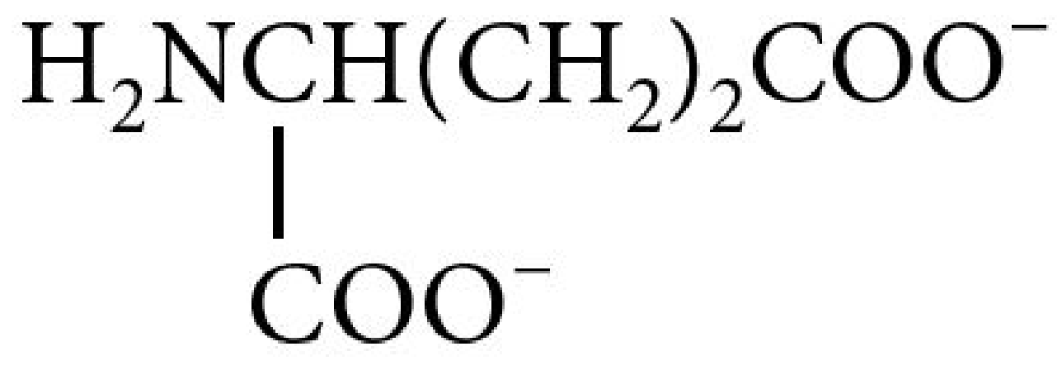
$$\underset{(C)}{CH_3-\underset{\underset{\displaystyle CH_3}{|}}{CH}-NC} \xrightarrow{Reduction} \underset{\text{Isopropylmethyl amine}}{CH_3-\underset{\underset{\displaystyle CH_3}{|}}{CH}-NH-CH_3}$$

49. **(d):** In highly alkaline conditions or at high pH, the carboxylic group is deprotonated.

Thus, $H_2NCH(CH_2)_2COOH$ exists as



$$H_2N\underset{\underset{\displaystyle COOH}{|}}{C}H(CH_2)_2COOH$$



$$H_2N\underset{\underset{\displaystyle COO^-}{|}}{C}H(CH_2)_2COO^-$$

50. **(b):** S_N2 mechanism is followed in case of primary and secondary alkyl halides *i.e.*, S_N2 reaction is favoured by small groups on the carbon atoms attached to halogen so, $CH_3-X > R-CH_2-X > R_2CH-X > R_3C-X$.

Primary alkyl halides are is more reactive towards S_N2 than secondary and tertiary alkyl halides.

51. **(a):** For (1) $n + l = 5$; $n = 4$

(2) $n + l = 4$; $n = 4$

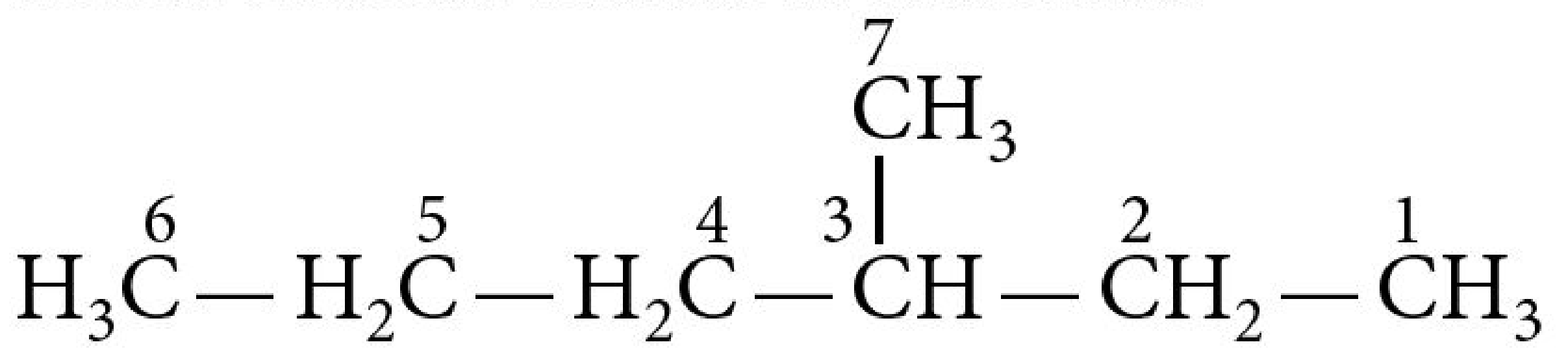
(3) $n + l = 5$; $n = 3$

(4) $n + l = 4$; $n = 3$

Lower $(n + l)$ means less energy and if for two subshells $(n + l)$ is same then lower the value of n, lower will be the energy.

Thus, correct order is (4) < (2) < (3) < (1).

52. **(a):** 3-Methylhexane can yield seven different mono-chlorinated products upon free radical chlorination, as the chemical environment of all the seven carbon atoms is different.



$$\overset{6}{H_3C}-\overset{5}{H_2C}-\overset{4}{H_2C}-\overset{3}{\underset{}{CH}}(\overset{7}{CH_3})-\overset{2}{CH_2}-\overset{1}{CH_3}$$

53. **(b):** Fehling solution does not oxidise aromatic aldehydes.

54. **(b):** Reactivity decreases as the number of $-NO_2$ groups at *o*- and *p*-positions with respect to Br decreases. *m*-Nitrobromobenzene is, however, less reactive than the *p*-nitrobromobenzene since, the $-NO_2$ group at *m*-position cannot stabilise the intermediate carbanion by resonance. Thus, the order is II > IV > III > I.

55. **(b):** For a first order reaction, $t_{1/2} = 0.693/k$

or $k = 0.693/t_{1/2}$

$$\therefore\ k = \frac{0.693}{10\ \text{min}} = 0.0693\ \text{min}^{-1} \simeq \frac{0.0693}{60}\text{s}^{-1}$$

$$= 0.001155\text{s}^{-1}$$

Now, from the Arrhenius equation, $k = Ae^{-Ea/RT}$

$$\text{or}\quad \ln k = \ln A - \frac{E_a}{RT} \quad \text{or} \quad \log k = \log A - \frac{E_a}{2.303RT}$$

Substituting the given values, we get

$$\log 0.001155 = \log(4\times10^{13}) - \frac{98.6\times10^3}{2.303\times8.314\times T}$$

$$\text{or}\quad -2.9374 = 13.6020 - \frac{5149.6}{T}$$

$$\text{Hence, } T = \frac{5149.6}{(13.6020+2.9374)}\text{K} = 311.35\ \text{K}$$

56. **(a):** $Mg(OH)_2 \rightleftharpoons \underset{s}{Mg^{2+}} + \underset{2s}{2OH^-}$

pH of $Mg(OH)_2$ solution is 10.

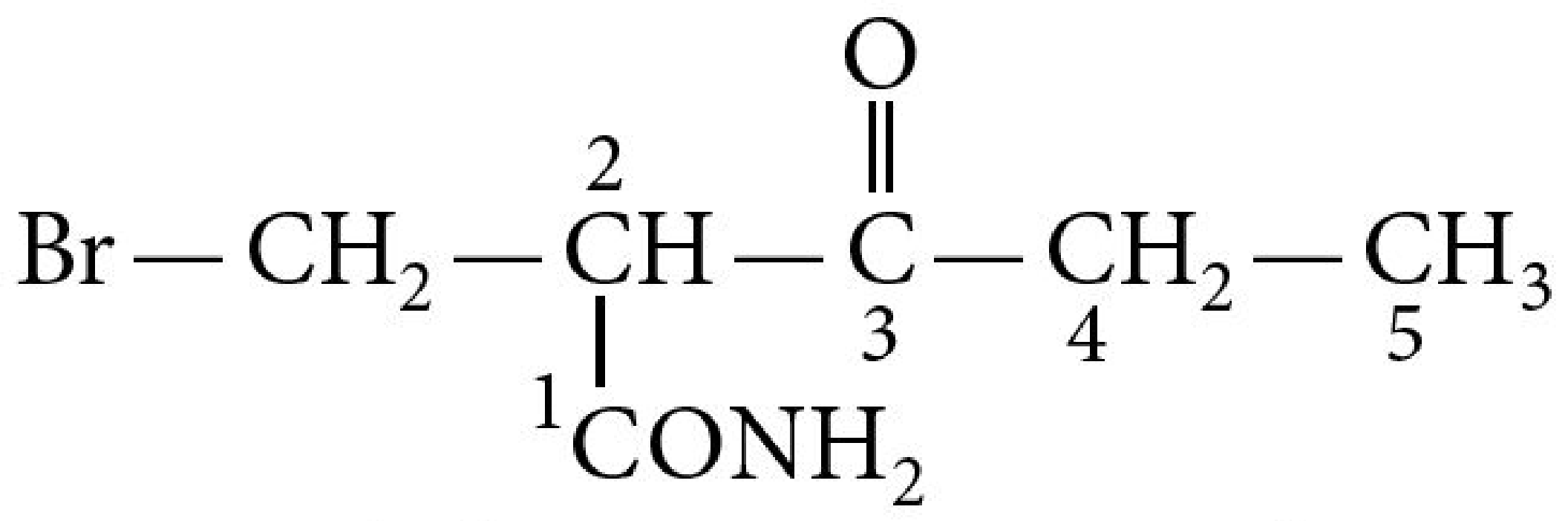
$\therefore$ pOH = 4

So, $[OH^-] = 10^{-4}$

$[OH^-] = 2 \times$ solubility

$$\therefore\ \text{Solubility} = \frac{10^{-4}}{2} = 0.5\times10^{-4} = 5\times10^{-5}\ \text{mol L}^{-1}$$

57. **(d):**



$$Br-CH_2-\overset{2}{\underset{\underset{\displaystyle ^1CONH_2}{|}}{CH}}-\underset{3}{\overset{\overset{\displaystyle O}{\|}}{C}}-\underset{4}{CH_2}-\underset{5}{CH_3}$$

2-Bromomethyl-3-oxopentanamide.

Terminal functional group, $-CONH_2$ is given more preference over $-\overset{\overset{\displaystyle O}{\|}}{C}-$.

58. **(a):** In $K_3[Fe(CN)_6]$, the ligand has satisfied both primary and secondary valencies of ferric ion.

59. **(c):** $K\overset{+7}{Mn}O_4 \xrightarrow{+1e^-} \overset{+6}{Mn}O_4^{2-}$

$K\overset{+7}{Mn}O_4 \xrightarrow{+3e^-} \overset{+4}{Mn}O_2$

$K\overset{+7}{Mn}O_4 \xrightarrow{+4e^-} \frac{1}{2}\overset{+3}{Mn_2}O_3$

$K\overset{+7}{Mn}O_4 \xrightarrow{+5e^-} Mn^{2+}$

60. **(b):** Size of ions depend on $\frac{Z}{e}$ ratio, larger is the $\frac{Z}{e}$ ratio, smaller will be the ion.

(i) $F^- = \frac{Z}{e} = \frac{9}{10} = 0.9$ (ii) $O^{2-} = \frac{Z}{e} = \frac{8}{10} = 0.8$

(iii) $Na^+ = \frac{Z}{e} = \frac{11}{10} = 1.1$ (iv) $Al^{3+} = \frac{Z}{e} = \frac{13}{10} = 1.3$

Thus, $Al^{3+} < Na^+ < F^- < O^{2-}$

◆◆

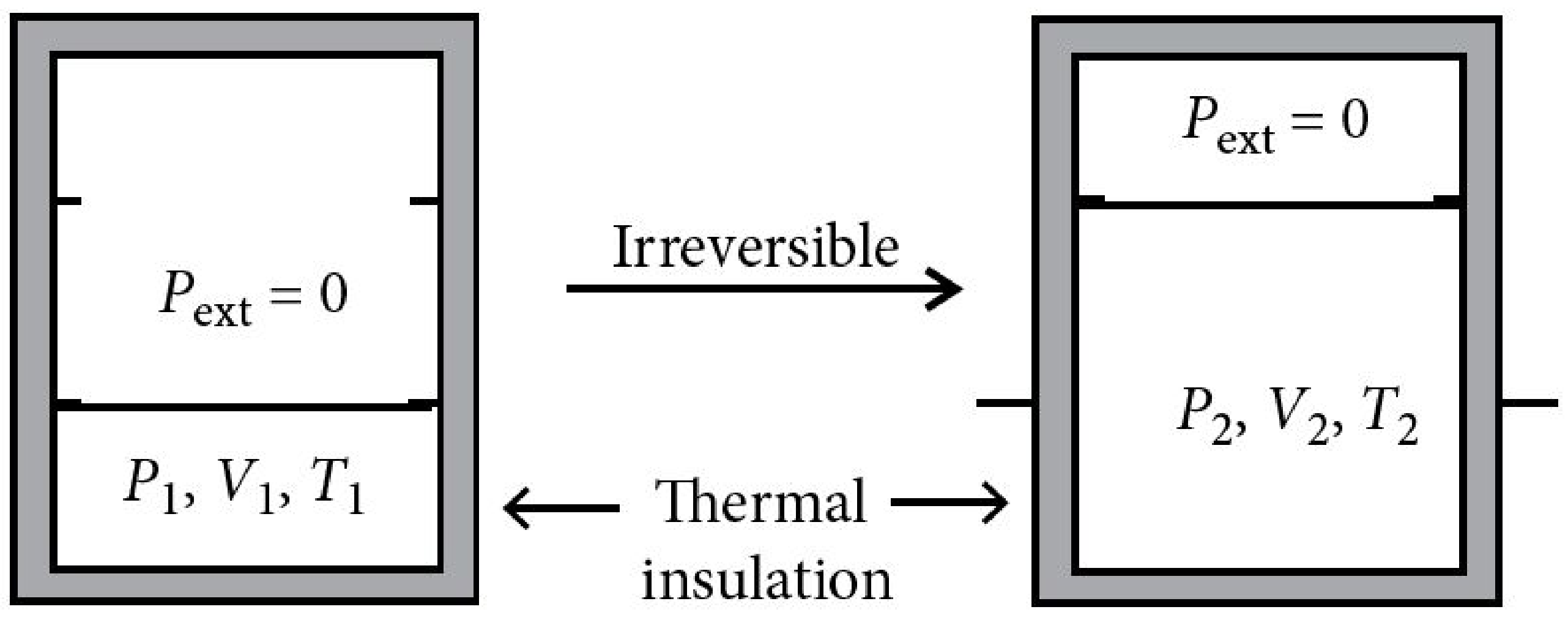
JEE Advanced Work Outs

ONE OR MORE THAN ONE OPTION CORRECT TYPE

1. Which of the following statement(s) is(are) correct?
(a) The electronic configuration of Cr is $[Ar]3d^5 4s^1$. (Atomic number of Cr = 24)
(b) The magnetic quantum number may have a negative value.
(c) In silver atom, 23 electrons have a spin of one type and 24 of the opposite type. (Atomic number of Ag = 47)
(d) The oxidation state of nitrogen in HN_3 is – 3.

2. If same quantity of electricity is passed through three electrolytic cells containing $FeSO_4$, $Fe_2(SO_4)_3$ and $Fe(NO_3)_3$, then which of the following options is/are incorrect?
(a) The amount of iron deposited in $FeSO_4$ and $Fe_2(SO_4)_3$ are equal.
(b) The amount of iron deposited in $FeSO_4$ is 1.5 times of the amount of iron deposited in $Fe(NO_3)_3$.
(c) The amount of iron deposited in $Fe_2(SO_4)_3$ and $Fe(NO_3)_3$ are equal.
(d) The same amount of gas is evolved in all three cases at the anode.

3. An ideal gas in a thermally insulated vessel at internal pressure = P_1, volume = V_1 and absolute temperature = T_1 expands irreversibly against zero external pressure, as shown in the diagram. The final internal pressure, volume and absolute temperature of gas are P_2, V_2 and T_2, respectively. For this expansion,



(a) $q = 0$
(b) $T_2 = T_1$
(c) $P_2V_2 = P_1V_1$
(d) $P_2V_2^{\gamma} = P_1V_1^{\gamma}$

4. $D(+)\text{-glucose} \xrightarrow{5(CH_3CO)_2O} (D)(+)\text{-glucose}$ pentaacetate.
Which of the following statement (s) is/are false about the product?
(a) It will reduce Tollens' reagent.
(b) It will reduce Fehling reagent.
(c) It reacts with phenylhydrazine.
(d) It doesn't undergoes aldol condensation.

5. When zeolite, which is hydrated sodium aluminium silicate, is treated with hard water the sodium ions are exchanged with
(a) H^+ ions
(b) Ca^{2+} ions
(c) SO_4^{2-} ions
(d) Mg^{2+} ions

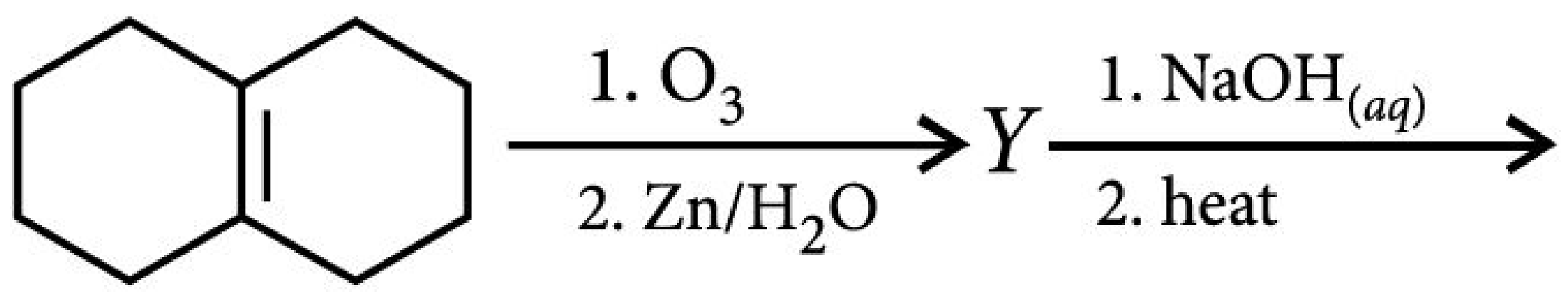
6. For a first order reaction,
(a) the degree of dissociation is equal to $(1 - e^{-kt})$
(b) a plot of reciprocal concentration of the reactant *vs* time gives a straight line
(c) the time taken for the completion of 75% reaction is thrice the $t_{1/2}$ of the reaction
(d) the pre-exponential factor in the Arrhenius equation has the dimension of time, T^{-1}.

NON-NEGATIVE INTEGER VALUE TYPE

7. The total number of lone-pairs of electrons in melamine is ________.

8. The pH of the solution formed by mixing 20 mL of 0.05 M H_2SO_4 with 5.0 mL of 0.45 M NaOH at 298 K is ________.

9. In the scheme given below, the total number of intramolecular aldol condensation products formed from '*Y*' is

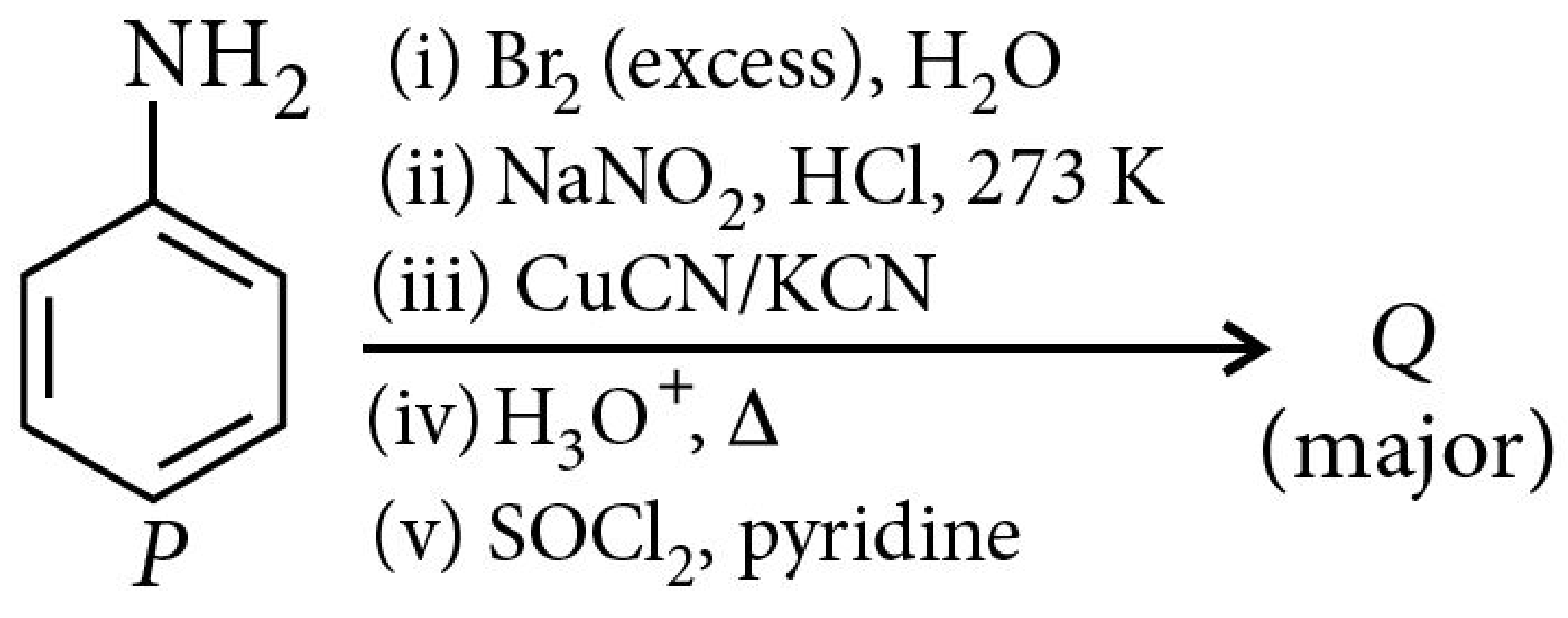


10. White phosphorous reacts with limited chlorine and the product is hydrolysed in the presence of water. What would be the mass of HCl (in g) obtained by the hydrolysis of the product formed by the reaction of 62 g of white phosphorus with chlorine in the presence of water?

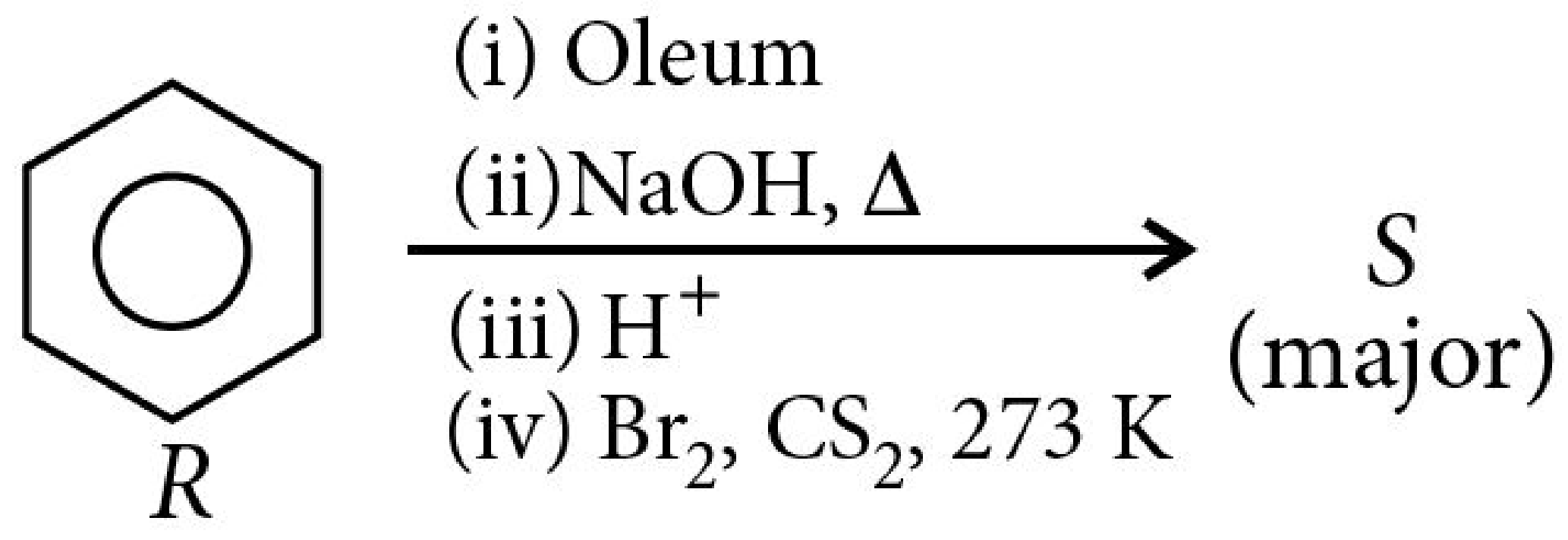
11. 0.5 g mixture of $K_2Cr_2O_7$ and $KMnO_4$ was treated with excess of KI in acidic medium. I_2 liberated required 100 cm^3 of 0.15 N $Na_2S_2O_3$ solution of titration. The percentage amount of $K_2Cr_2O_7$ in the mixture is ______.

12. Schemes 1 and 2 describe the conversion of *P* to *Q* and *R* to *S*, respectively. Scheme 3 describes the synthesis of *T* from *Q* and *S*. The total number of Br atoms in molecules of *T* and *S* is ____.

Scheme 1 :



Scheme 2 :



Scheme 3 : $S \xrightarrow[\text{(ii) } Q]{\text{(i) NaOH}} \underset{\text{(major)}}{T}$

MATCHING TYPE

13. Match list-I with list-II and select the correct option.

List-I (Species)		List-II (Hybrid Orbitals)	
(P)	$XeOF_2$	1.	sp^3d^2
(Q)	IF_5	2.	d^2sp^3
(R)	CO_2	3.	sp^3d
(S)	NH_4^+	4.	sp^3
		5.	sp

Choose the correct answer from the options given below:

(a) (P) – (3), (Q) – (1), (R) – (5), (S) – (4)
(b) (P) – (2), (Q) – (1), (R) – (4), (S) – (5)
(c) (P) – (4), (Q) – (3), (R) – (2), (S) – (5)
(d) (P) – (1), (Q) – (2), (R) – (5), (S) – (3)

14. Match list-I with list-II and select the correct option.

List-I		List-II	
(P)	Square close packing in two dimensions.	1.	Triangular void
(Q)	Hexagonal close packing in two dimensions	2.	Pattern of sphere is repeated in every fourth layer.
(R)	Hexagonal close packing in three dimensions.	3.	Coordination number 4
(S)	Cubic close packing in three dimensions	4.	Coordination number 3
		5.	Pattern of sphere is repeated in alternate layers

(a) (P) – 3, (Q) – 4, (R) – 2, (S) – 5
(b) (P) – 3, (Q) – 1, (R) – 5, (S) – 2
(c) (P) – 1, (Q) – 4, (R) – 3, (S) – 2
(d) (P) – 1, (Q) – 2, (R) – 4, (S) – 3

15. Match the column-I with column-II to identify the products of oxidation of alkanes.

Column-I		Column-II	
(P)	$(CH_3)_3CH + 2O_2 \xrightarrow[[O]]{KMnO_4}$	1.	$HCOOH + H_2O$
(Q)	$2CH_4 + O_2 \xrightarrow[100\text{ atm}]{Cu/523\text{ K}}$	2.	$(CH_3)_3COH$
(R)	$CH_4 + O_2 \xrightarrow[\Delta]{Mo_2O_3}$	3.	$2CH_3OH$
(S)	$CH_4 + \frac{3}{2}O_2 \xrightarrow{(CH_3COO)_2Mn}$	4.	$HCHO + H_2O$
		5.	H_3CCOOH

(a) (P) → (1), (Q) → (2), (R) → (5), (S) → (4)
(b) (P) → (2), (Q) → (3), (R) → (4), (S) → (1)
(c) (P) → (4), (Q) → (2), (R) → (3), (S) → (5)
(d) (P) → (3), (Q) → (1), (R) → (2), (S) → (4)

16. Match the list-I with list-II and select the correct option.

List-I		List-II	
(P)	Xerogel	1.	Gel
(Q)	Cold cream	2.	Protecting power
(R)	Imbibition	3.	Water in oil
(S)	Oildag	4.	Cellophane
		5.	Graphite sol

(a) (P) – 4, (Q) – 1, (R) – 2, (S) – 5
(b) (P) – 1, (Q) – 3, (R) – 2, (S) – 4
(c) (P) – 4, (Q) – 3, (R) – 1, (S) – 5
(d) (P) – 1, (Q) – 4, (R) – 2, (S) – 3

PARAGRAPH WITH NUMERICAL VALUE

PARAGRAPH-1

An intimate mixture of Fe_2O_3 and Al is used in solid fuel rocket. $\Delta H_{Al_2O_3} = 399.0$ kcal, $\Delta H_{Fe_2O_3} = 199.0$ kcal Density of Fe_2O_3 and Al are 5.2 g ml^{-1} and 2.7 g ml^{-1} respectively.

17. Total volume of the fuel mixture is ______ mL.

18. The fuel value per g of the mixture is ______ k $cal.g^{-1}$.

PARAGRAPH-2

The pressure in a bulb dropped from 2000 to 1500 mm Hg in 47 min when the contained oxygen leaked through a small hole. The bulb was then completely evacuated. A mixture of oxygen and another gas having molecular weight 79 g in the molar ratio 1 : 1 at a total pressure of 4000 mm Hg was introduced.

19. Partial pressure of unknown gas at the end of 74 minute is ______ mm Hg.

20. The molar ratio of the two gases remaining in the bulb after 74 minutes is ______.

SOLUTIONS

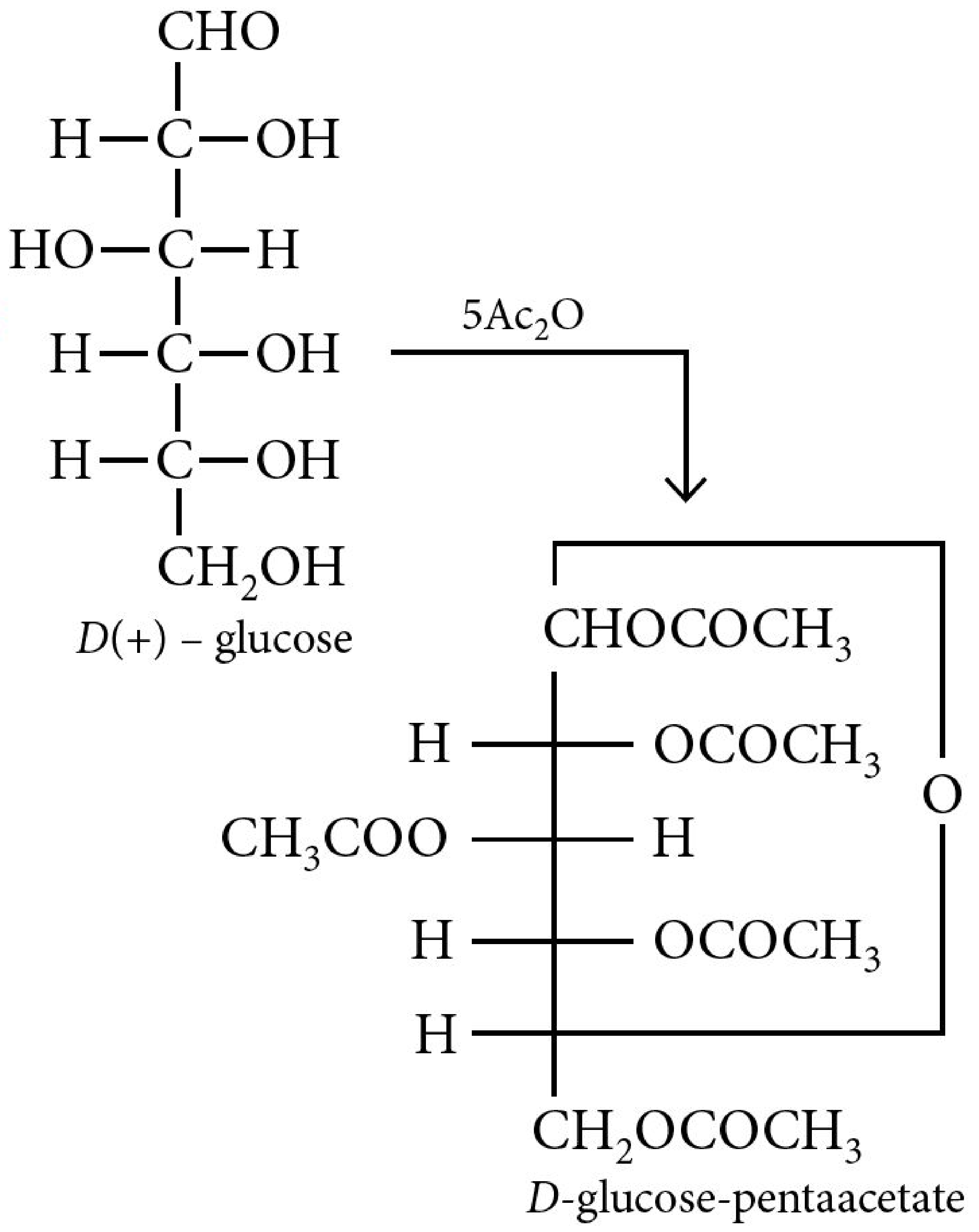
1. (a,b,c) : (a) is the correct electronic configuration of Cr($Z = 24$), $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$.
(b) is correct because magnetic quantum number (m_l) can have values from $-l$ ...... 0 ..... $+l$ *i.e.* it can have negative values.
(c) is correct because the electronic configuration of Ag ($Z = 47$) is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^1$.
From here we find 23 electrons have spin of one type and 24 electrons have spin of opposite type.
(d) is not correct because oxidation number of N in HN_3 is $-1/3$.

2. (a) : Assume 1 F charge is passed through,

	$FeSO_4$	$Fe_2(SO_4)_3$	$Fe(NO_3)_3$
Amount of Fe deposited	$\frac{56}{2}$	$\frac{56}{3}$	$\frac{56}{3}$

3. (a, b, c) : Since vessel is thermally insulated, *i.e.* the process is adiabatic hence, $q = 0$
Also, $P_{ext} = 0$, hence $w = 0$
From 1st law of thermodynamics, $\Delta E = q + w$
$\therefore\ \Delta E = 0$ (for ideal gas)
$\therefore\ \Delta T = 0$ or $T_2 = T_1$
[$\because$ Internal energy of an ideal gas is a function of temperature.]
Applying ideal gas equation, $PV = nRT$
where n, R and T are constant.
then $P_1V_1 = P_2V_2$
Equation, PV^{γ} = constant, is applicable only for ideal gas in reversible adiabatic process.
Hence, $P_2V_2^{\gamma} = P_1V_1^{\gamma}$ equation is not applicable.

4. (a, b, c) :



D(+) – glucose

D-glucose-pentaacetate

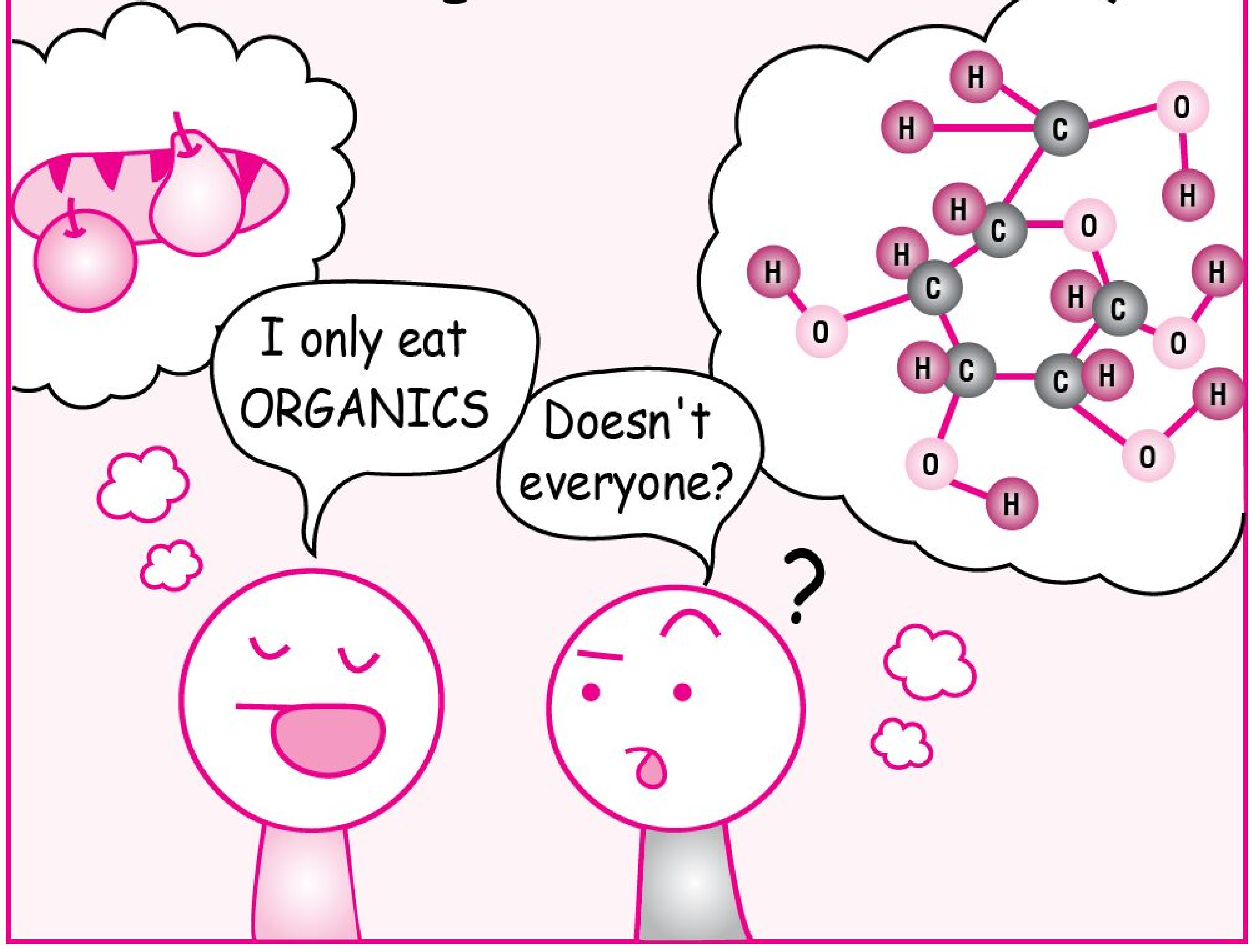
Glucose pentaacetate does not contain the aldehydic group & hence it will not give tests of aldehydes.

5. (b, d) : The sodium ions of zeolite are exchanged with calcium and magnesium ions when hard water is passed through it.

$Na_2Al_2Si_2O_8 \cdot xH_2O + Ca^{2+} \rightarrow CaAl_2Si_2O_8 \cdot xH_2O + 2Na^+$
$Na_2Al_2Si_2O_8 \cdot xH_2O + Mg^{2+} \rightarrow MgAl_2Si_2O_8 \cdot xH_2O + 2Na^+$

CHEM CAPSULE

Talking with a Chemist.



6. (a,d) : For a first order reaction, α is the degree of dissociation

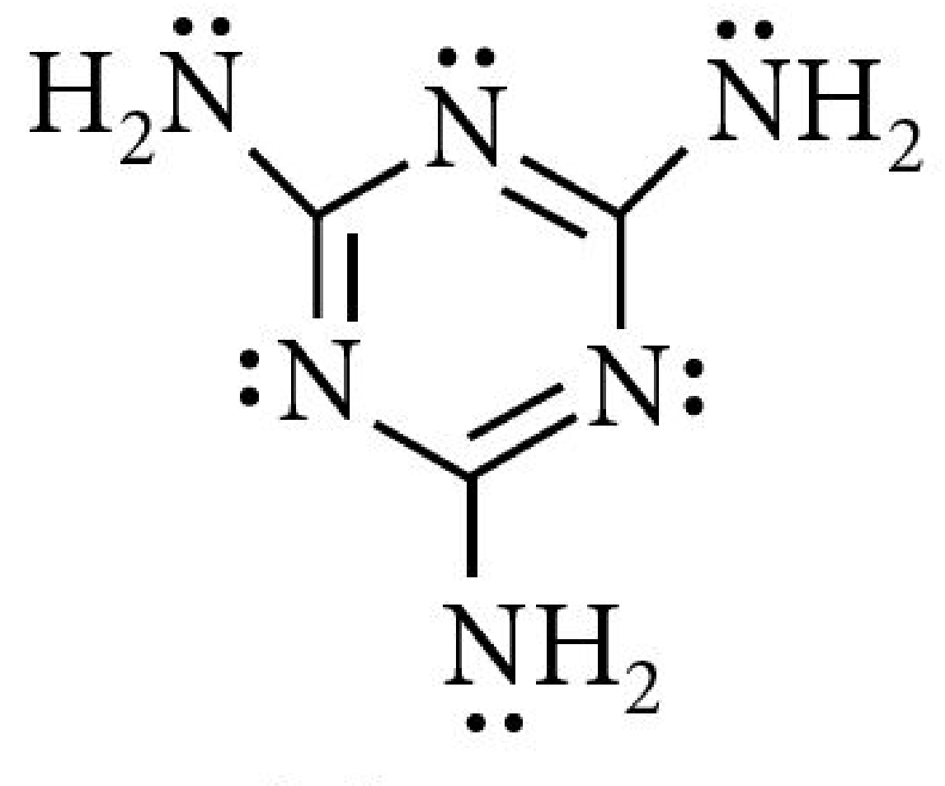
$$\therefore \quad k \cdot t = \ln \frac{1}{1-\alpha} = -\ln(1-\alpha)$$

or $e^{-k.t.} = (1-\alpha)$ or $\alpha = 1 - e^{-k.t}$

As, Arrhenius equation is, $k = A.e^{(-E_a/RT)}$

The dimensions of pre-exponential factor (A) are the same as those of k, which is T^{-1} for a first order reaction.

7. (6) : Structure of melamine is


H2N̈
N̈
N̈H2
:N
N:
N̈H2

Total no. of lone pair of electrons = 6.

8. (12) : $2NaOH + H_2SO_4 \rightleftharpoons Na_2SO_4 + 2H_2O$

Millimoles of $H_2SO_4 = 20 \times 0.05 = 1$ millimole

Millimoles of NaOH = $5 \times 0.45 = 2.25$ millimole

Total volume of the solution = 20 + 5 = 25 mL

2 millimoles of NaOH react with 1 millimole of H_2SO_4

Millimoles of $H^+ = 2 \times 1 = 2$

Millimoles of $OH^- = 2.25$

2 millimoles of H^+ will neutralise 2 millimoles of OH^-, thus 0.25 millimoles of OH^- will be left in the solution.

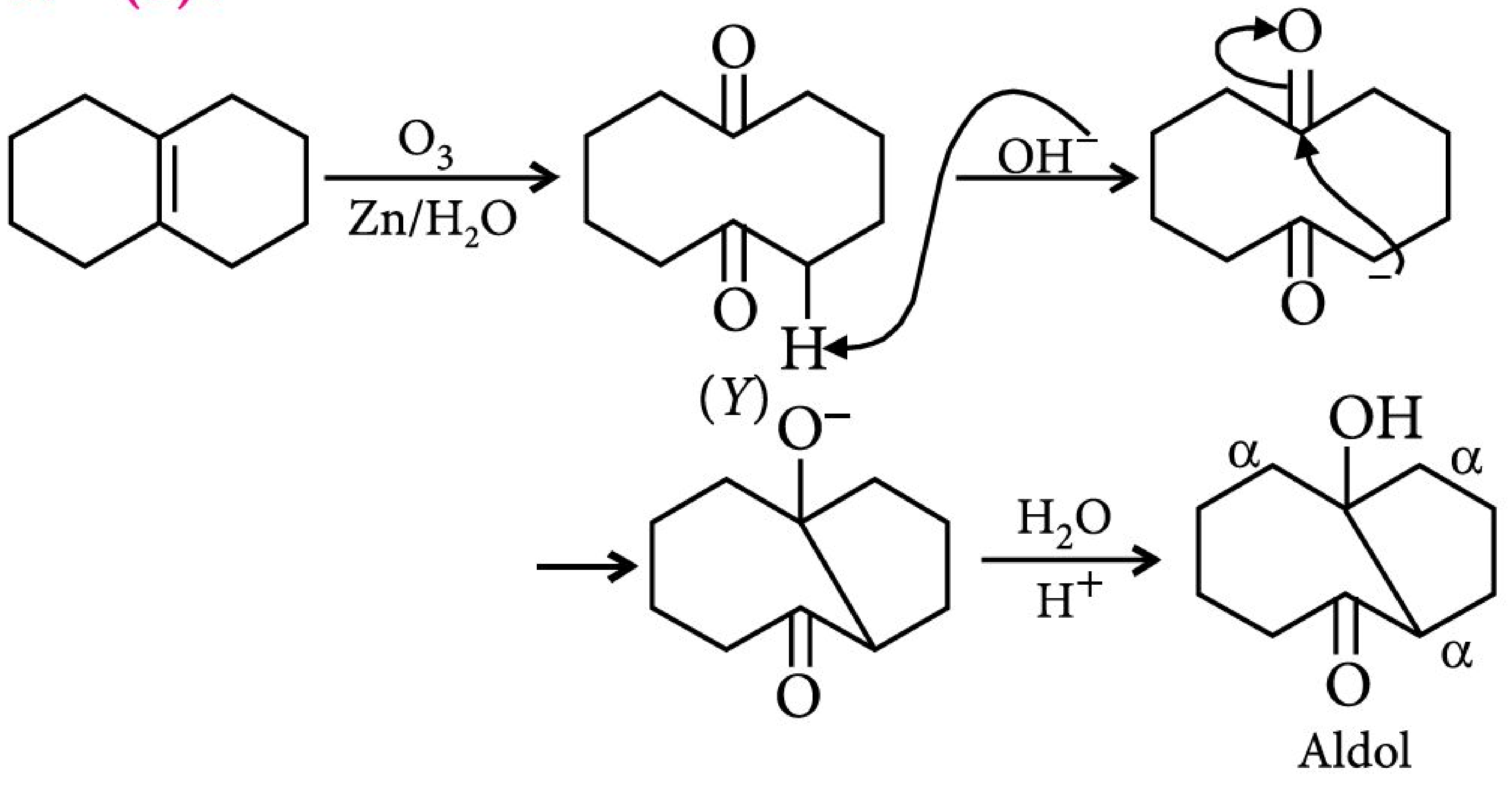
Concentration of OH^- in the solution

$$= \frac{0.25}{25} = 0.01 = 10^{-2} \text{ M}$$

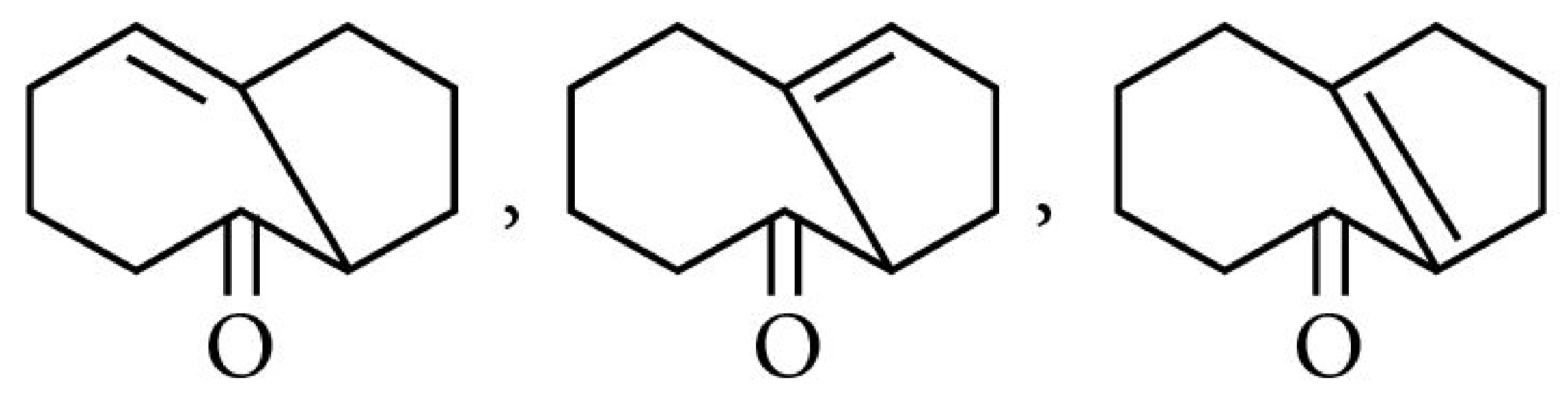
pOH = $-\log(1 \times 10^{-2}) = 2$;

pH = 14 − 2 = 12

9. (3) :


O3
Zn/H2O
O
O
H
(Y)
OH−
O
O
−
O−
O
H2O
H+
OH
α
α
α
O
Aldol

The aldol has 3 type of α-hydrogen atoms and hence gives three dehydration products.



10. (219) : $P_4 + 6Cl_2 \longrightarrow 4\,PCl_3$

$[PCl_3 + 3H_2O \longrightarrow H_3PO_3 + 3HCl\,] \times 4$

Overall reaction

$P_4 + 6\,Cl_2 + 12\,H_2O \longrightarrow 4H_3PO_3 + 12\,HCl$

1 mol P_4 produces 12 moles HCl

$$\text{Moles of } P_4 = \frac{62}{124} = \frac{1}{2} \text{ mol}$$

$\frac{1}{2}$ mole will produce 6 moles HCl

Mass of HCl = $6 \times 36.5 = 219$ g

11. (15) : Let the amount of the $K_2Cr_2O_7$ in the mixture be x g, the amount of $KMnO_4$ will be $(0.5 - x)$g.

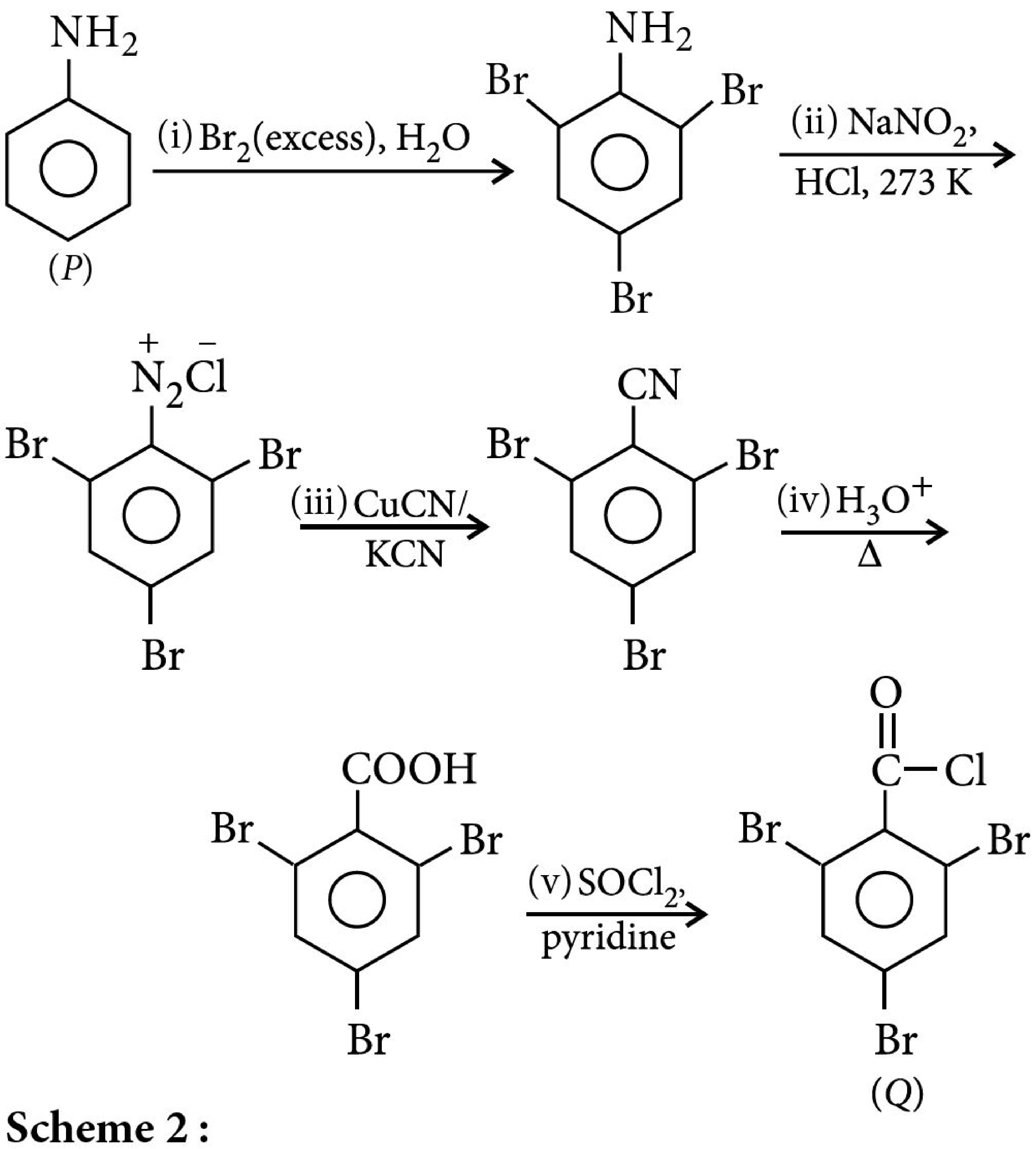
$$\therefore \quad \left(\frac{x}{49} + \frac{0.5-x}{31.6}\right) = \frac{100 \times 0.15}{1000}$$

Where 49 is eq. wt. of $K_2Cr_2O_7$ and 31.6 is eq. wt. of $KMnO_4$.

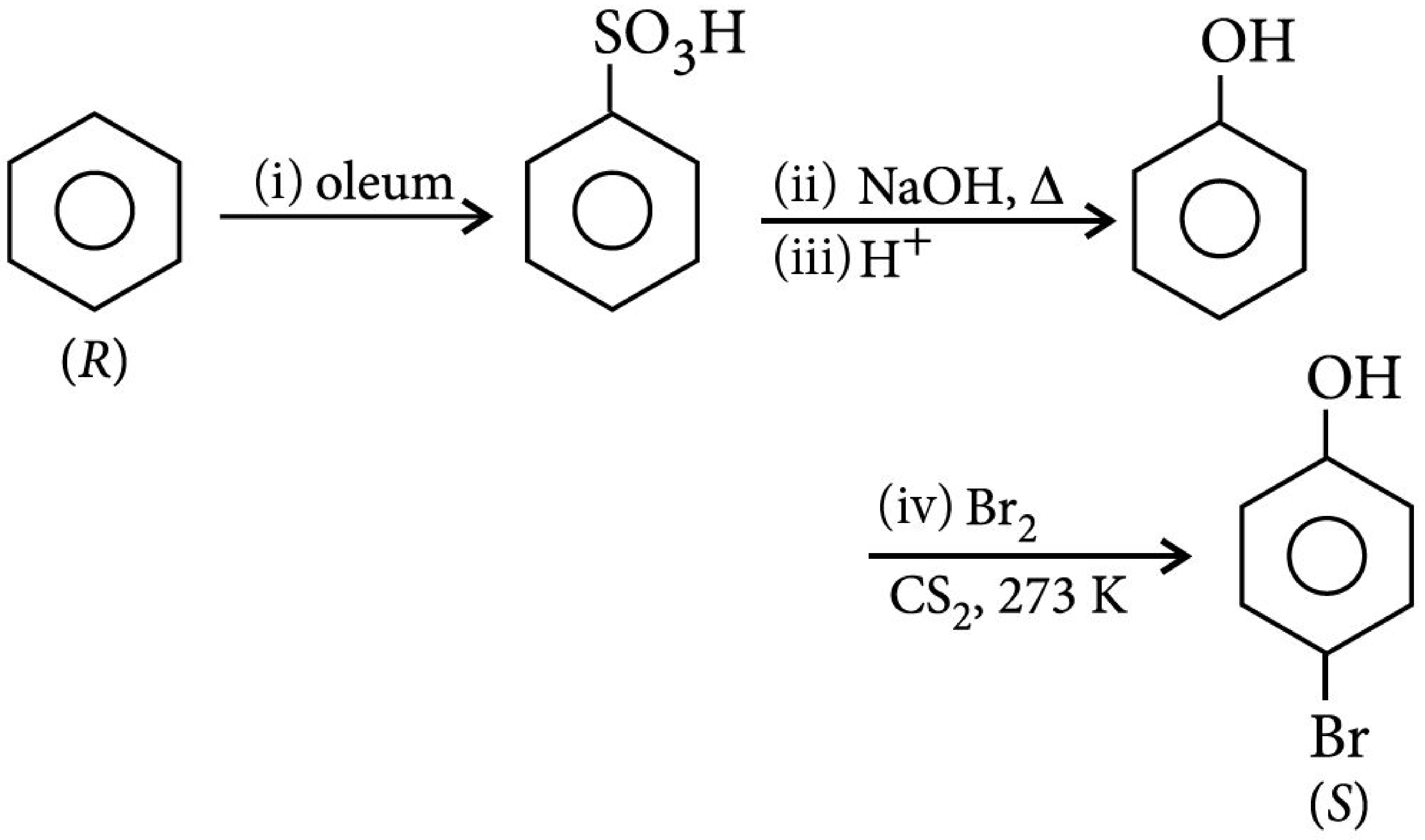
On solving, we get $x = 0.073$ g

$$\text{Percentage of } K_2Cr_2O_7 = \frac{0.073 \times 100}{0.5} = 14.6\%$$

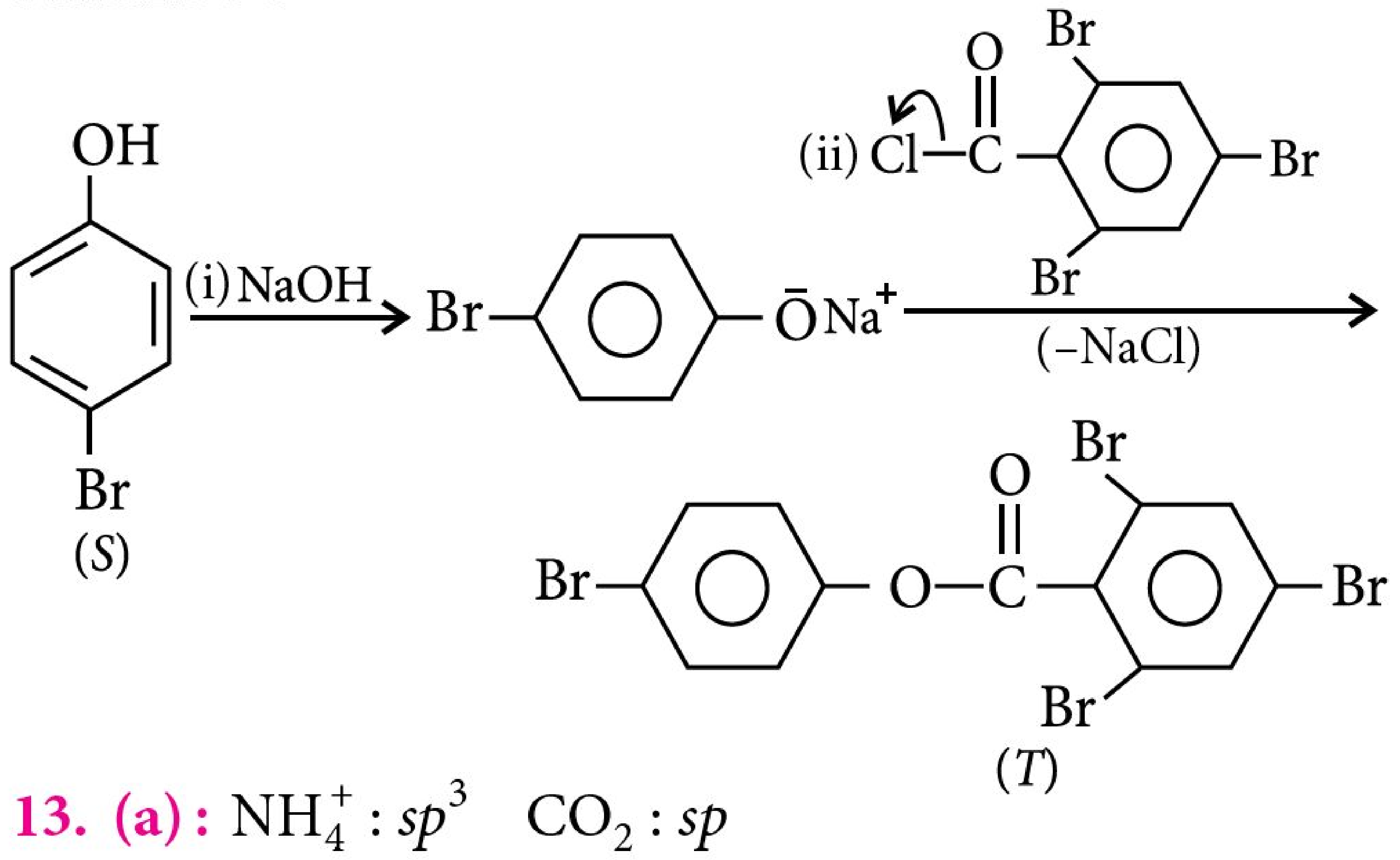
12. (7) : Scheme 1 :


NH2
(P)
(i) Br2(excess), H2O
NH2
Br
Br
Br
(ii) NaNO2,
HCl, 273 K
N2Cl
Br
Br
Br
(iii) CuCN/
KCN
CN
Br
Br
Br
(iv) H3O+
Δ
COOH
Br
Br
Br
(v) SOCl2,
pyridine
O
C−Cl
Br
Br
Br
(Q)

Scheme 2 :


(R)
(i) oleum
SO3H
(ii) NaOH, Δ
(iii) H+
OH
(iv) Br2
CS2, 273 K
OH
Br
(S)

Scheme 3 :

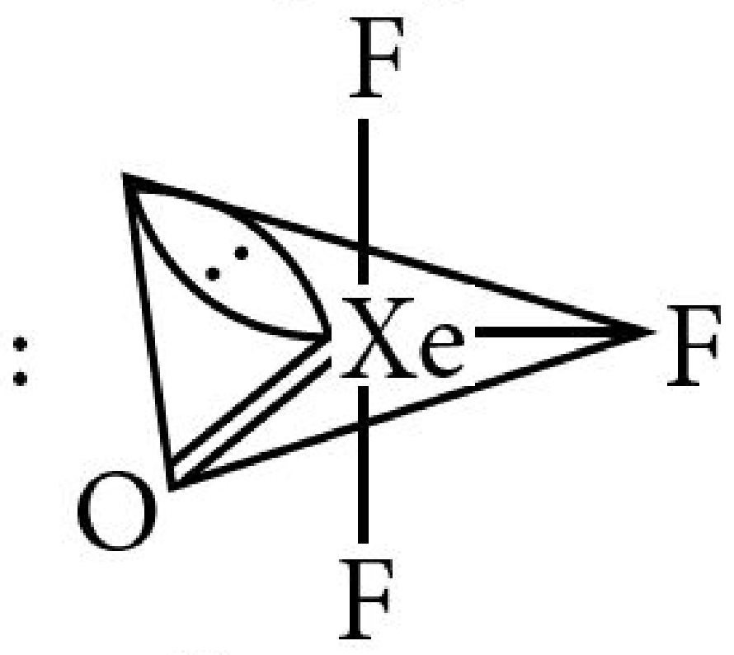


(S)

(T)

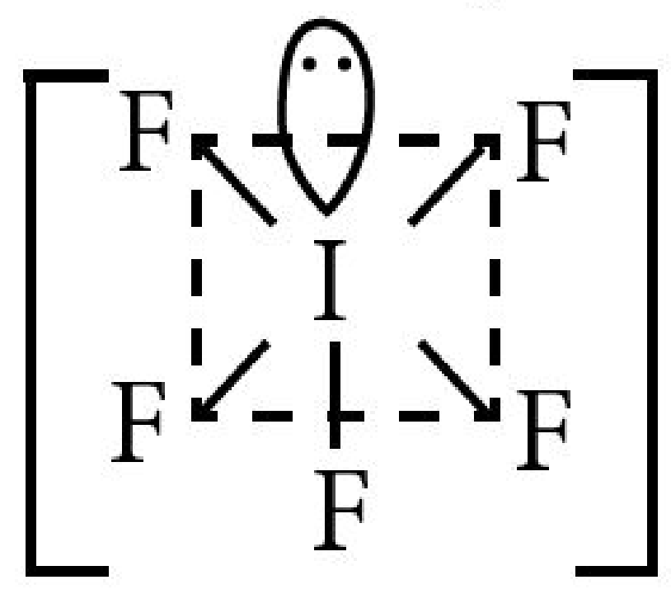
13. (a) : $NH_4^+ : sp^3$ $CO_2 : sp$

$XeOF_2$:



sp^3d

IF_5 :



sp^3d^2

14. (b) **15. (b)** **16. (c)**

17. (50.77) : Molecular mass of fuel mixture

$2Al + Fe_2O_3)$

$= 2 \times 27 + 2 \times 56 + 3 \times 16 = 214$

Total volume of fuel mixture $= \left(\frac{160}{5.2} + \frac{54}{2.7}\right) = 50.77$ ml.

18. (0.94) : $2Al_{(s)} + \frac{3}{2}O_{2(g)} \rightarrow Al_2O_{3(s)}$,

$\Delta H = 399.0$ kcal ...(i)

$2Fe_{(s)} + \frac{3}{2}O_{2(g)} \rightarrow Fe_2O_{3(s)}$, $\Delta H = 199.0$ kcal ...(ii)

Subtracting eq. (ii) from eq. (i), we get

$2Al_{(s)} + Fe_2O_{3(s)} \rightarrow Al_2O_{3(s)} + 2Fe_{(s)}$, $\Delta H = 200.0$ kcal

$\because$ 214 g of fuel mixture liberates heat = 200 kcal

$\therefore$ 1 g of fuel mixture liberates heat $= \frac{200}{214} \times 1$

$= 0.9346$ kcal g^{-1}.

19. (1499) : Since the mixture contains 1 : 1 molar ratio of oxygen and another gas, partial pressures of oxygen and the second gas would be same as 2000 mm Hg, respectively. Now in 74 min, the decrease of partial pressure of oxygen would be

$$-\Delta p_{O_2} = \frac{(2000 - 1500) \text{ mm Hg}}{47 \text{ min}} \times 74 \text{ min}$$

= 787.2 mm Hg.

Now the ratio of rate of diffusion would be

$$\frac{r_1}{r_2} = \sqrt{\frac{32}{79}} = 0.6364$$

Thus, $-\Delta p_{\text{unknown gas}} = 0.6364 \times 787.2$ mm Hg = 501 mm Hg

Partial pressure of unknown gas at the end of 74 min

= (2000 – 501) mm Hg = 1499 mm Hg.

20. (1.24) : Partial pressure of oxygen at the end of 74 min = (2000 – 787.2) mm Hg = 1212.8 mm Hg

Now since the amount of the gas remaining will be directly proportional to its partial pressure, we would have

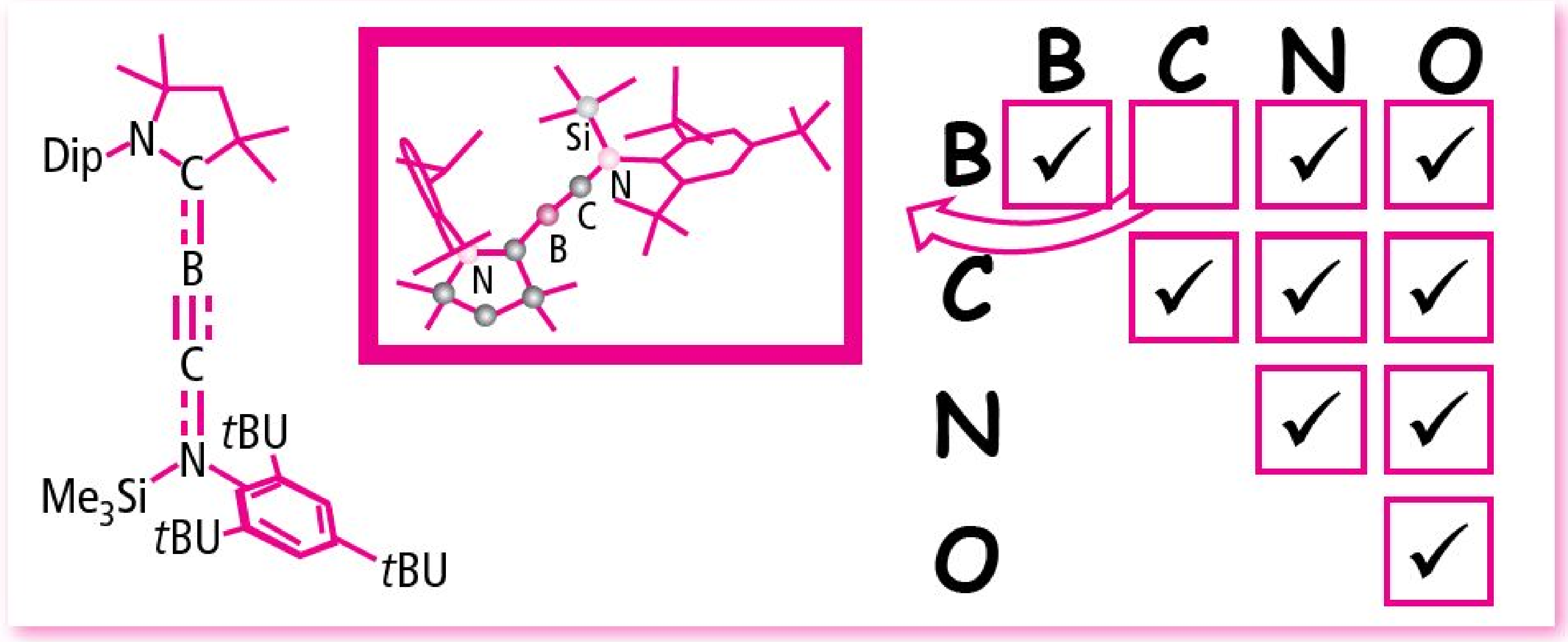
$$\frac{n_1}{n_2} = \frac{1499}{1212.8} = \frac{1.236}{1}.$$

◆◆

Chemistry bulletin

Triple bond formed between boron and carbon for the first time

Boron, carbon, nitrogen and oxygen: these four elements can form chemical triple bonds with each other due to their similar electronic properties. Examples of this are the gas carbon monoxide, which consists of one carbon and one oxygen atom, or the nitrogen gas in the Earth's atmosphere with its two nitrogen atoms.



Structure of the world's first molecule with a triple bond between boron (B) and carbon (C). Credit Rian..

Chemistry recognizes triple bonds between all possible combinations of the four elements—but not between boron and carbon. This is astonishing because there have long been stable double bonds between boron and carbon. In addition, many molecules are known in which triple bonds exist between two carbon atoms or between two boron atoms.

Chemists at Julius-Maximilians-Universität (JMU) Würzburg in Bavaria, Germany, have now closed this gap: A team led by boron expert Professor Holger Braunschweig has succeeded for the first time in synthesizing a molecule with a boron-carbon triple bond, a so-called boryne, which exists as an orange solid at room temperature.

Quiz CLUB

Unlock Your Knowledge!

1. Isomers differing in their configuration at a chiral atom are called _______.
2. A trade name for halothane is _______.
3. _______ are the polysaccharides which on hydrolysis give only galactose.
4. _______ is generally an unwanted material or impurity that is present in an ore.
5. The reactant which gets consumed completely and limits the amount of product formed is called _______.
6. The lower limit of shell, n = _______in Pfund series.
7. Elements of group 11 are called _______ metals.
8. The name of newest halogen with iupac name ununheptium is _________.
9. With increase in s character electronegativity of an element _________.
10. Behaviour of Li and Be is more similar with the second element of the following group *i.e.*, Mg and Al respectively. This is because of _________.
11. The _________ of a polar molecule is given by the product of the charge at one end and the distance between the opposite charges .
12. The number of hydrogen bonds made by each H_2O molecule in ice is __________.
13. _______is a mixture of NH_4NO_3 and TNT ,which is used as an explosive.
14. In PCl_5, there are two types of bonds, one is axial and other is ________.
15. The first discovered organic compound is ________.
16. Carbon disulphide has ________ structure .
17. For precipitation to occur , the ionic product should be _______ than solubility product.
18. _______ is an enzyme which hydrolyses nucleic acids.
19. _______is an asbestos mineral used in acid resistant filters.
20. Trioxane is the solid polymer of ____________.

◆

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month. Winners' names and answers will be published in next issue.

TRIO

ANSWERS **APRIL 2025**

The 3 sets of trio are **(YCL, CYL, LYC), (LID, DIL, LDI) and (BOR, RBO, ORB)**

A**CY**C**L**IC
A**CYL**
G**LYC**OL
HA**LID**E
DILUTE
ARY**LDI**AZONIUM
BORON
CA**RBO**NYL
ADS**ORB**ATE

Winners : *Poorna N. Rao,Komal*

GK CORNER

Enhance Your General Knowledge with Current Updates!

SPORTS

- Mumbai Indians have secured their second Women's Premier League (WPL) title by successfully defending a 150-run target against Delhi Capitals at the Brabourne Cricket Stadium on Saturday, March 15.
- The 38th edition of the National Games took place from 28th January to 14th February 2025 in Uttarakhand. The mascot of the games was Mauli, inspired by Uttarakhand's state bird, the Monal, reflecting the region's natural beauty and cultural diversity. The tagline for the games was "Sankalp Se Shikhar Tak" (from resolution to zenith).
- The Khelo India Winter Games 2025 were organized in two phases to promote and develop winter sports in India. Phase 1 was held from 23 to 27 January 2025, in Leh, Ladakh and included ice sports like Ice Hockey and Ice Skating. Phase 2 took place from 9 to 12 March 2025, in Gulmarg, Jammu & Kashmir, featuring snow sports such as Ski Mountaineering, Alpine Skiing, Snowboarding, and Nordic Skiing. The Indian Army was crowned overall champions with 18 medals (7 gold, 5 silver, and 6 bronze), followed by Himachal Pradesh and Ladakh.
- The Times of India Sports Awards (TOISA) 2024 in Lucknow honoured athletes and mentors for their achievements. TOISA is an annual event by The Times of India that celebrates excellence in Indian sports, honouring athletes, teams, and coaches across various disciplines. The theme for the year 2025 was #MoreSweatMoreGlory, emphasizing dedication and perseverance in sports.
- The Indian senior women's basketball team won the SABA Women's Championship 2025, defeating Maldives by 107-32 in the final. This was the first time that the Indian team was participating in the SABA Women's Championship. It was organised by the South Asian Basketball Association and hosted by the Basketball Federation of India at the KD Jadhav Indoor Stadium in New Delhi from 23 to 26 February 2025.
- With a stellar showing and ten medals overall, India concluded their 2025 Senior Asian Wrestling Championship campaign in Amman. Udit and Deepak Punia maintained their strong competitive records by winning silver medals. Dinesh and Mukul Dahiya, among other wrestlers, fought hard but came very close to winning gold. The tournament demonstrated India's prowess in freestyle wrestling, showcasing both established and up-and-coming wrestlers on the continental scene.
- Indian wrestler Sunil Kumar won a bronze medal in the 87 kg Greco-Roman category at the Asian Wrestling Championship 2025 in Amman, Jordan. After losing to Iran's Yasin Yazdi in the semifinals, Sunil bounced back to defeat China's Jiaxin Huang for bronze. Sunil, a former silver medallist (2019), began his campaign with a dominant 10-1 victory over Tajikistan's Sukhrob Abdulkhaev in the quarterfinals.
- The fifth edition of the ISTAF World Cup was held from 20 to 25 March 2025 at the Patliputra Indoor Stadium in Kankarbagh, Patna. Sepaktakraw is a

traditional Malaysian sport that is extremely popular in Southeast Asian countries. It is organised by the International Sepak Takraw Federation (ISTAF) while it is hosted by the Indian Sepak Takraw Federation. Twenty countries of the world participated in this World Cup, which included more than 300 players and coaches.

- Ajinkya Rahane made history by becoming the first Indian player to captain three different IPL teams. In IPL 2025, he led Kolkata Knight Riders (KKR) in their opening match against Royal Challengers Bengaluru at Eden Gardens, marking his 26th game as an IPL captain. Rahane previously captained Rising Pune Supergiant in 2017 and Rajasthan Royals in 2018-2019.
- Indian Women's Hockey stalwart, Vandana Katariya announced her retirement from international hockey on 2 April 2025. With an illustrious career spanning 15 years, she has made her mark as India's most-capped woman hockey player in international matches. With 320 international caps and 158 goals, Vandana Katariya retired as India's most experienced woman hockey player.

Test Yourself!

1. Vandana Katariya is associated with which sports?
(a) Cricket (b) Football
(c) Hockey (d) Tennis

2. Ajinkya Rahane made history by becoming the first Indian player to do what in the IPL?
(a) Score the most runs in an IPL season
(b) Captain three different IPL teams
(c) Win the IPL Player of the Tournament
(d) Play for four IPL teams

3. Which two wrestlers from India won silver medals at the 2025 Senior Asian Wrestling Championship?
(a) Dinesh and Mukul Dahiya
(b) Udit and Deepak Punia
(c) Udit and Dinesh
(d) Mukul Dahiya and Deepak Punia

4. Where was the fifth edition of the ISTAF World Cup held in 2025?
(a) Kuala Lumpur, Malaysia
(b) Patliputra Indoor Stadium, Patna
(c) New Delhi, India
(d) Bangkok, Thailand

5. Who did Sunil Kumar defeat to win the bronze medal at the 2025 Asian Wrestling Championships?
(a) Iran's Yasin Yazd
(b) China's Jiaxin Huang
(c) Tajikistan's Sukhrob Abdulkhaev
(d) Kazakhstan's Daniyar Khatibayev

6. What was the tagline for the 38th edition of the National Games?
(a) From Strength to Strength
(b) Unity in Diversity
(c) Sankalp Se Shikhar Tak
(d) Rise Above

7. Who hosted the 3rd SABA Women's Championship 2025?
(a) South Asian Basketball Association
(b) Basketball Federation of India
(c) International Basketball Federation (FIBA)
(d) Indian Olympic Association

8. Where was the Women's Premier League final held on 15 March 2025?
(a) Wankhede Stadium
(b) Eden Gardens
(c) Brabourne Cricket Stadium
(d) M. Chinnaswamy Stadium

9. Which sports were included in Phase 1 of the Khelo India Winter Games 2025?
(a) Ski Mountaineering and Alpine Skiing
(b) Ice Hockey and Ice Skating
(c) Snowboarding and Nordic Skiing
(d) Ice Hockey and Snowboarding

10. What was the theme for the Times of India Sports Awards (TOIS) 2024-25?
(a) #StrengthIn Unity
(b) #ChaseYour Dreams
(c) #MoreSweatMoreGlory
(d) #RiseToVictory

Answer Key

1. (c) **2.** (b) **3.** (b) **4.** (b) **5.** (b)
6. (c) **7.** (b) **8.** (c) **9.** (b) **10.** (c)

◆◆

GET SET GO for JEE

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1. The recommended daily dose is 17.6 milligrams of vitamin C (ascorbic acid) having formula $C_6H_8O_6$. Match the column-I with column-II and mark the appropriate choice.

Column-I		Column-II	
(A)	O-atoms present in 17.6 mg of vitamin C	(P)	10^{-4} mole
(B)	Moles of vitamin C in 1 g of vitamin C	(Q)	5.68×10^{-3}
(C)	Moles of vitamin C should be consumed daily	(R)	3.6×10^{20}

(a) (A) → (P), (B) → (Q), (C) → (R)
(b) (A) → (R), (B) → (Q), (C) → (P)
(c) (A) → (R), (B) → (P), (C) → (Q)
(d) (A) → (P), (B) → (R), (C) → (Q)

2. The ground state energy of hydrogen atom is −13.6 eV. The energy of second excited state of He^+ ion in eV is

(a) −3.4 (b) −54.4 (c) −27.2 (d) −6.04

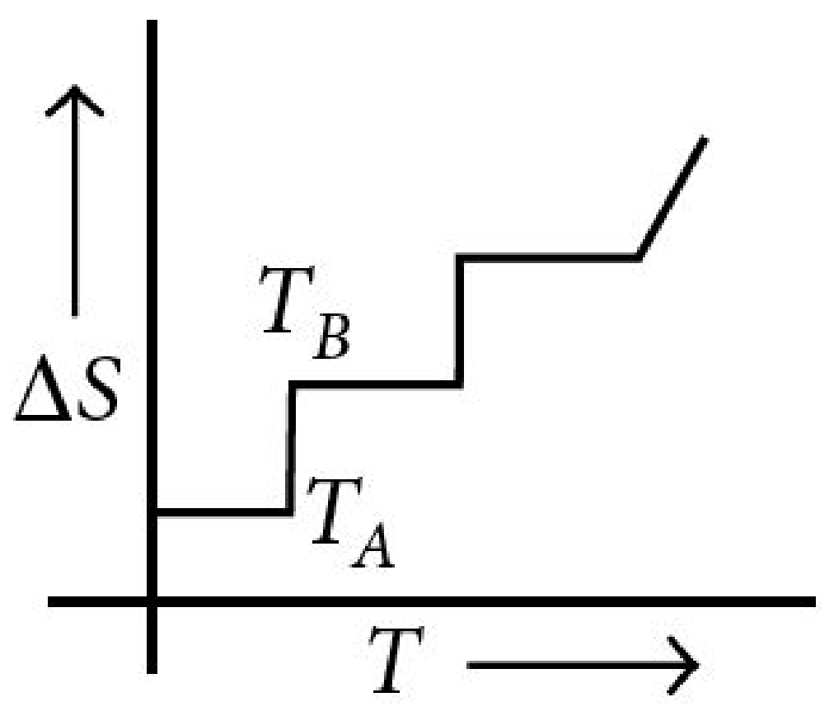
3. For Na^+, Mg^{2+}, F^- and O^{2-} ; the correct order of increasing ionic radii is

(a) $Mg^{2+} < Na^+ < F^- < O^{2-}$ (b) $O^{2-} < F^- < Na^+ < Mg^{2+}$
(c) $Na^+ < Mg^{2+} < F^- < O^{2-}$ (d) $Mg^{2+} < O^{2-} < Na^+ < F^-$

4. Assuming 2*s*-2*p* mixing is not operative, the paramagnetic species among the following is

(a) Be_2 (b) B_2 (c) C_2 (d) N_2

5. If for a given substance, melting point is T_B and freezing point is T_A, then correct variation shown by graph between entropy change and temperature is

(a)


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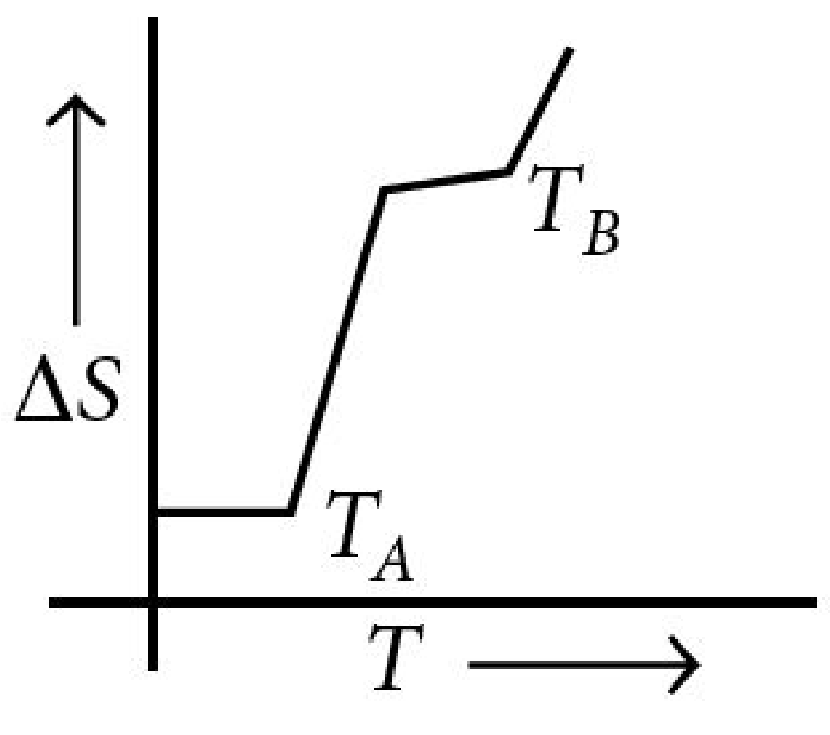

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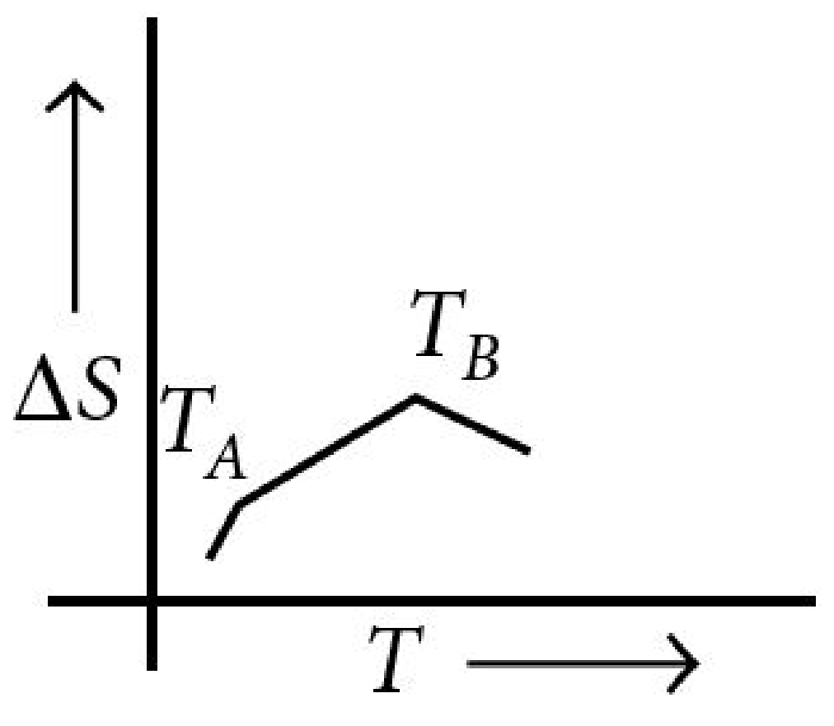

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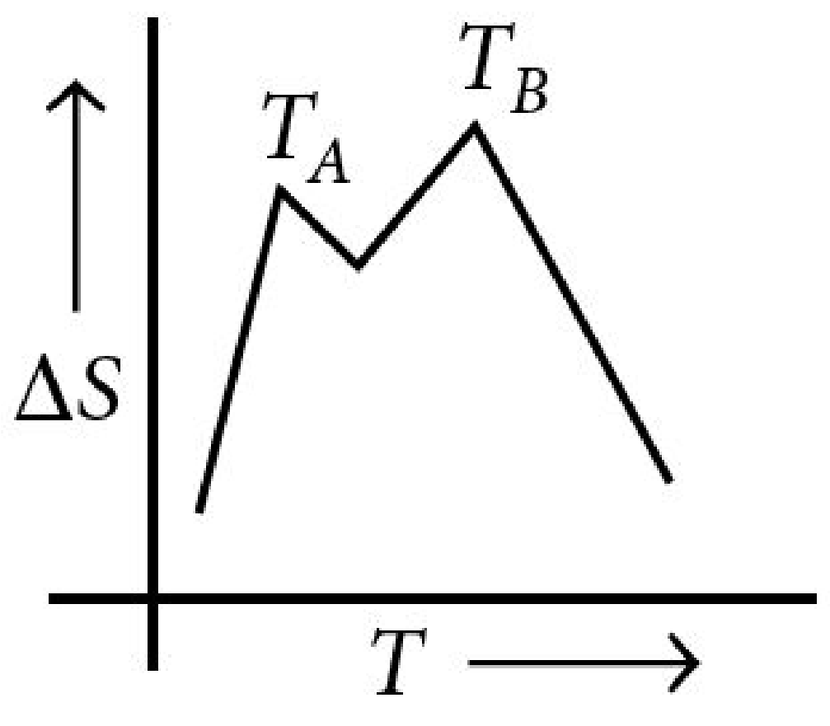


6. In which of the following reactions, H_2O_2 acts as a reducing agent?

(1) $H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$
(2) $H_2O_2 - 2e^- \rightarrow O_2 + 2H^+$
(3) $H_2O_2 + 2e^- \rightarrow 2OH^-$
(4) $H_2O_2 + 2OH^- - 2e^- \rightarrow O_2 + 2H_2O$

(a) (2), (4) (b) (1), (2)
(c) (3), (4) (d) (1), (3)

7. **Statement-I :** According to Saytzeff rule, less substituted alkene is the major product of dehydrohalogenation.

Statement-II : During elimination reaction, hydrogen atom is lost from β-carbon.

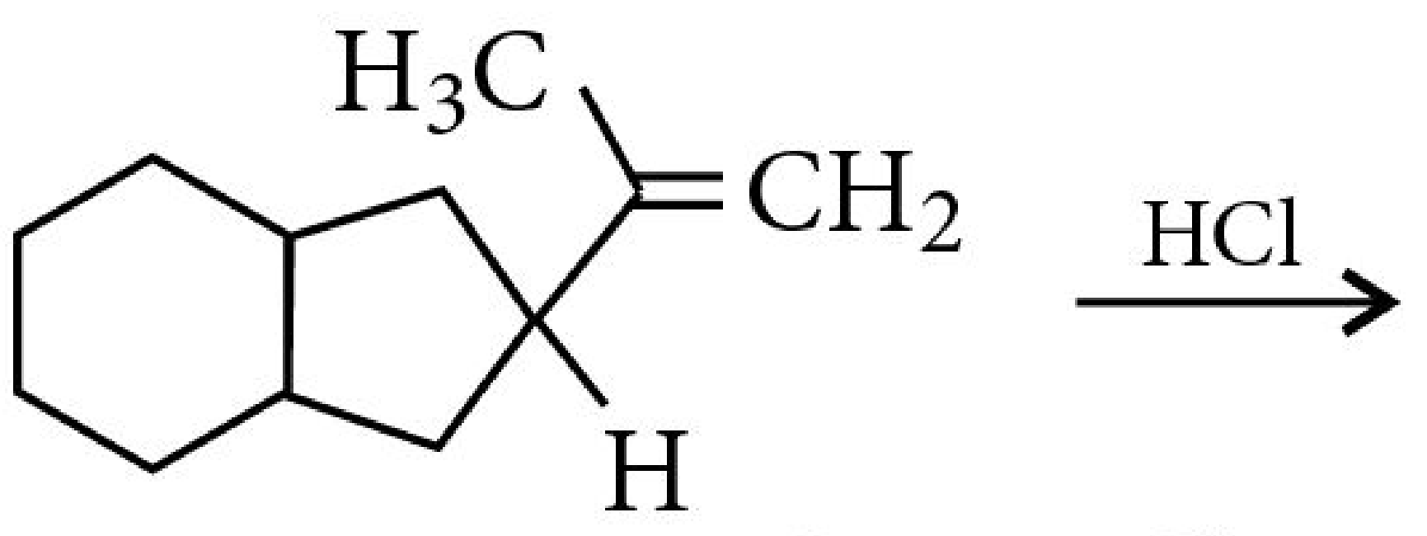
(a) Both statement-I and statement-II are correct.
(b) Statement-I is correct but statement-II is incorrect.
(c) Both statement-I and statement-II are incorrect.
(d) Statement-I is incorrect but statement-II is correct.

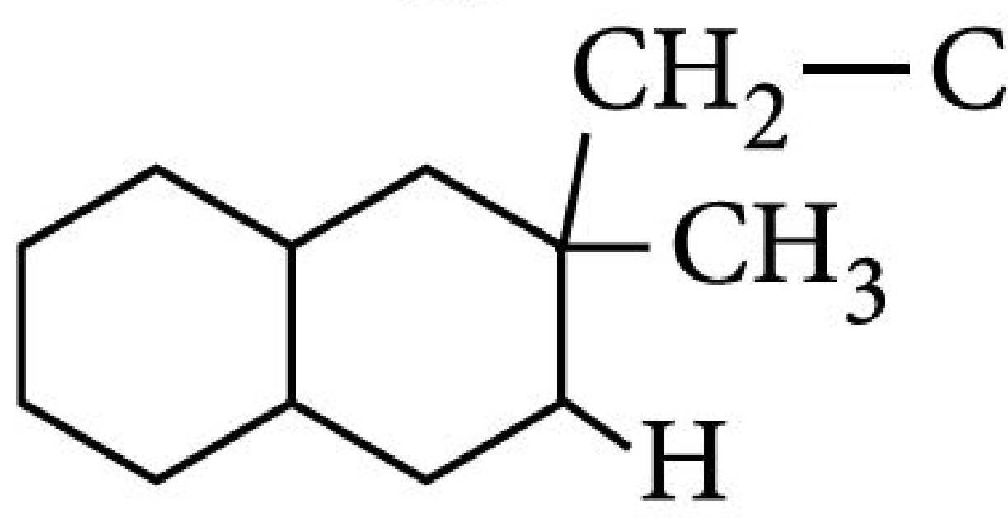
8. **Assertion :** Al forms $[AlF_6]^{3-}$ but B does not form $[BF_6]^{3-}$.

Reason : B does not react with fluorine.

(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

9. The major product of the following reaction is



(a)


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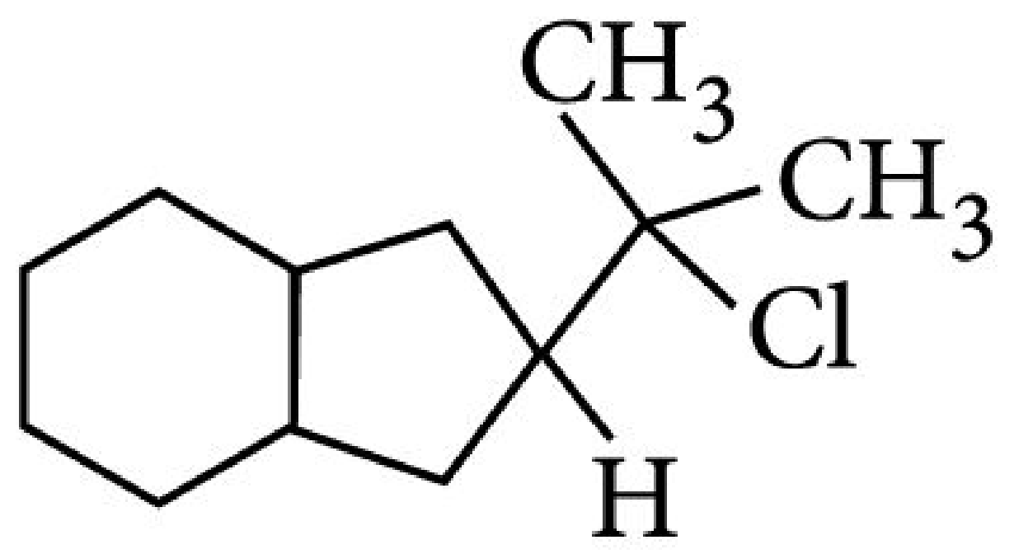
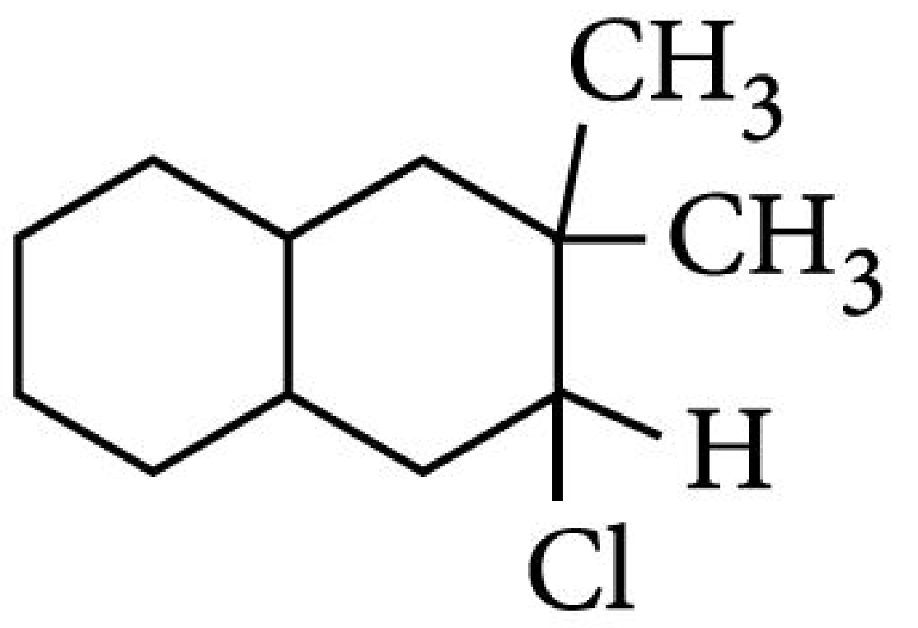
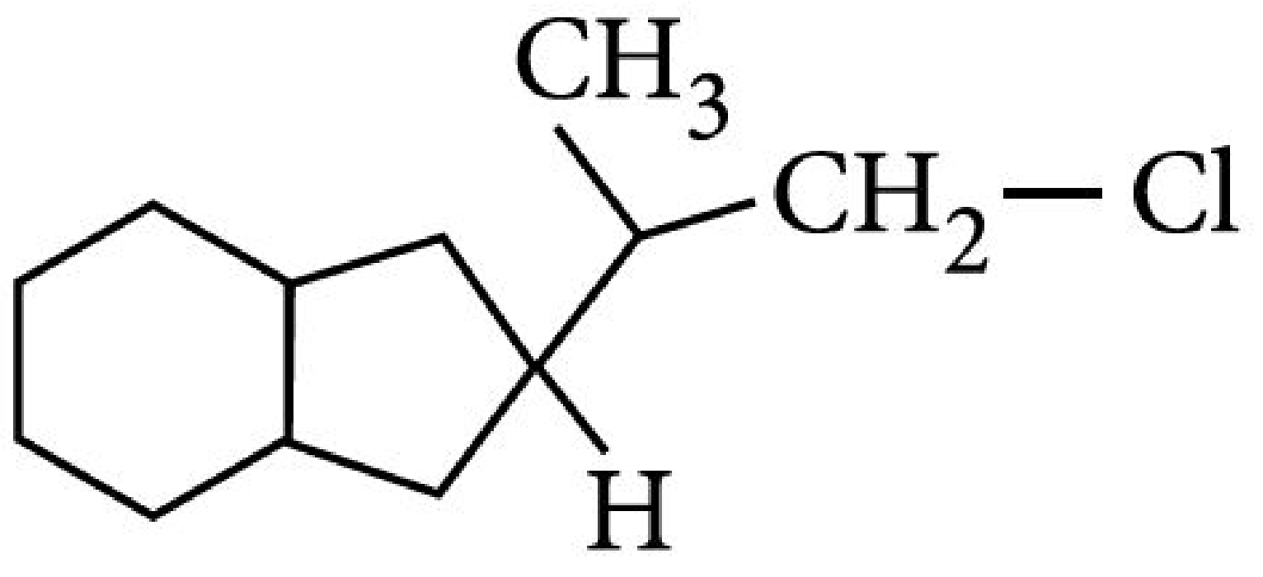


(c)


(d)


10. A solution contains 0.05 M each of NaCl and Na_2CrO_4. Solid $AgNO_3$ is gradually added to this solution. Mark out the correct statement. (Given $K_{sp}(AgCl) = 1.7 \times 10^{-10}\ M^2$ and $K_{sp}(Ag_2CrO_4) = 1.9 \times 10^{-12}\ M^3$)

(a) CrO_4^{2-} ions are precipitated first.
(b) Cl^- ions are precipitated first.
(c) Both Cl^- and CrO_4^{2-} ions are precipitated together.
(d) The second ion starts precipitating when half of the first ion is precipitated.

11. A chromatography column packed with silica gel as stationary phase, was used to separate a mixture of compounds consisting of (*A*) benzanilide, (*B*) aniline and (*C*) acetophenone. When the column is eluted with a mixture of solvents, hexane : ethyl acetate (20 : 80), the sequence of obtained compounds is

(a) (*B*), (*A*) and (*C*) (b) (*A*), (*B*) and (*C*)
(c) (*B*), (*C*) and (*A*) (d) (*C*), (*A*) and (*B*)

12. Which of the following resonating structures of 1-methoxy-1,3-butadiene is least stable?

(a) $\overset{-}{C}H_2-CH=CH-CH=\overset{+}{O}-CH_3$
(b) $CH_2=CH-\overset{-}{C}H-CH=\overset{+}{O}-CH_3$
(c) $\overset{-}{C}H_2-\overset{+}{C}H-CH=CH-O-CH_3$
(d) $CH_2=CH-\overset{-}{C}H-\overset{+}{C}H-O-CH_3$

INTEGER / NUMERICAL VALUE TYPE

13. The number of C-atoms in compound (*C*) are

$$CH\equiv CH \xrightarrow[NH_4Cl]{Cu_2Cl_2} (A) \xrightarrow{H_2 + Pd/BaSO_4} (B) \xrightarrow[\Delta]{CH\equiv CH} (C)$$

14. The number of species among the following which have fractional bond order is

Li_2, He_2^+, N_2^+, N_2^{2-}, O_2^+, O_2^{2-}, O_2^-, CO_3^{2-}, C_6H_6, O_3

15. For a dimerization reaction, $2A_{(g)} \rightarrow A_{2(g)}$, at 298 K, $\Delta U° = -20$ kJ mol^{-1}, $\Delta S° = -30$ J K^{-1} mol^{-1}, then the $\Delta G°$ will be ________ J.

SOLUTIONS

1. **(b) :** (A) 176 g of vitamin C has $6 \times N_A$ of 'O' atoms

17.6×10^{-3} g of vitamin C has $\frac{6 \times N_A}{176} \times 17.6 \times 10^{-3}$

$= 3.6 \times 10^{20}$ of O - atoms

(B) $n = \frac{1}{176} = 5.68 \times 10^{-3}$

(C) $\frac{W}{M} = \frac{17.6 \times 10^{-3}}{176} = 10^{-4}$

2. **(d) :** $E_n = E_1 \times \frac{Z^2}{n^2} = -13.6 \times \frac{2^2}{3^2} = -13.6 \times \frac{4}{9}$

$= -6.04$ eV

3. **(a)**

4. **(c) :** If 2*s*-2*p* mixing is not operative, then molecular orbitals may be arranged in order of energy as follows :

$\sigma 1s, \sigma^* 1s, \sigma 2s, \sigma^* 2s, \sigma 2p_z, \pi 2p_x = \pi 2p_y, \pi^* 2p_x = \pi^* 2p_y, \sigma^* 2p_z$

Applying this configuration, Be_2, B_2 and N_2 will be diamagnetic, but C_2 will be paramagnetic.

5. **(a) :** For a pure substance T_A and T_B represent the same temperature. Hence (a) is a correct choice.

6. **(a) :** The reducing agent itself gets oxidised *i.e.*, the oxidation number increases.

$$(1)\quad H_2\overset{-1}{O_2} + 2H^+ + 2e^- \longrightarrow 2H_2\overset{-2}{O}$$

$$(2)\quad H_2\overset{-1}{O_2} - 2e^- \longrightarrow \overset{0}{O_2} + 2H^+$$

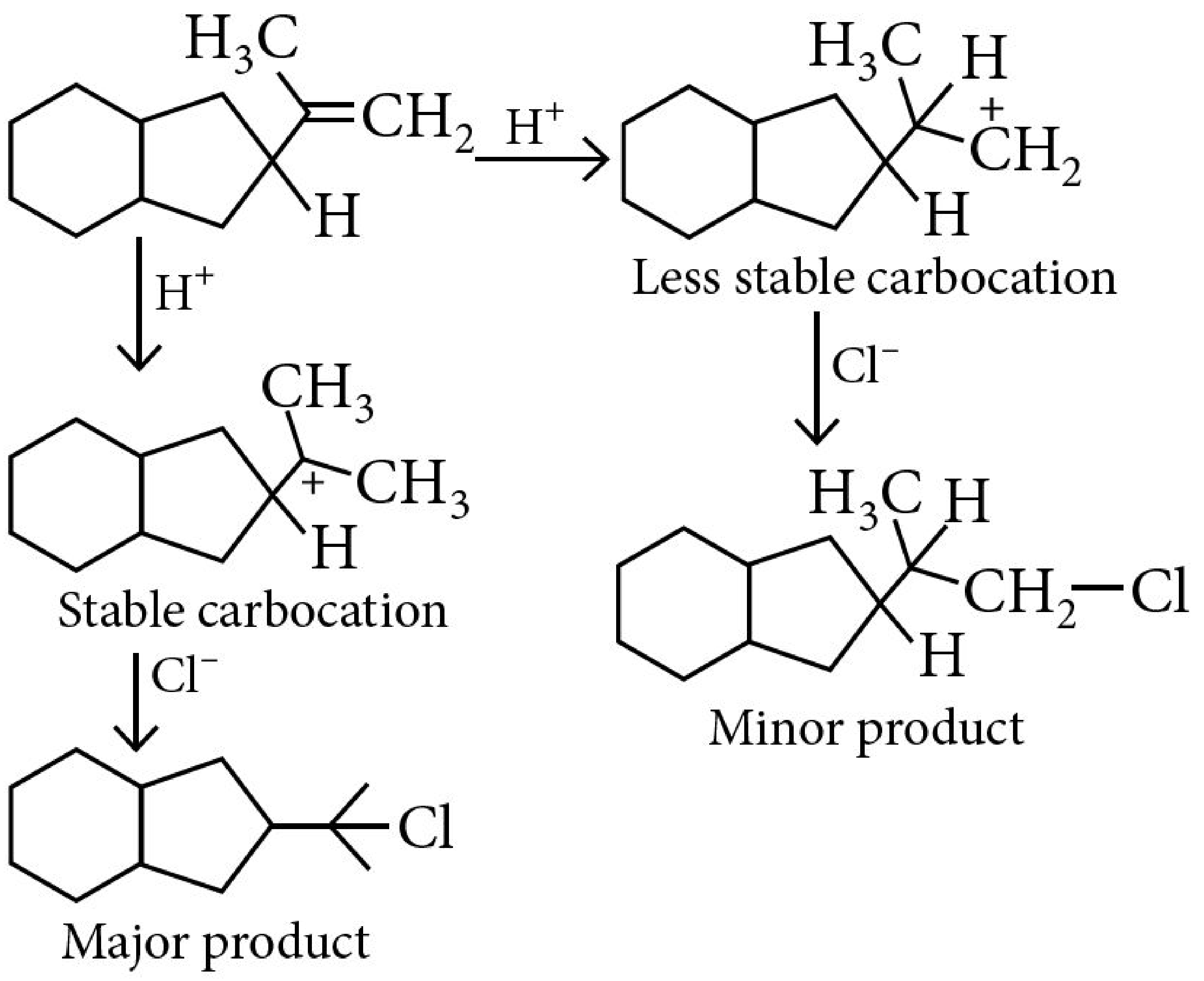
$$(3)\quad H_2\overset{-1}{O_2} - 2e^- \longrightarrow 2\overset{-2}{O}H^+$$

$$(4)\quad H_2\overset{-1}{O_2} + 2OH^- - 2e^- \longrightarrow \overset{0}{O_2} + 2H_2O$$

7. **(d)**

8. **(c) :** B does not have vacant *d*-orbitals (sub-shell) in its valence shell. Boron reacts with F_2 to form boron trifluorides.

9. **(b) :**



10. **(b) :** Ag^+ ions required to precipitate Cl^-

$$= \frac{K_{sp}(AgCl)}{0.05} = \frac{1.7\times10^{-10}}{0.05} = 34\times10^{-10}$$

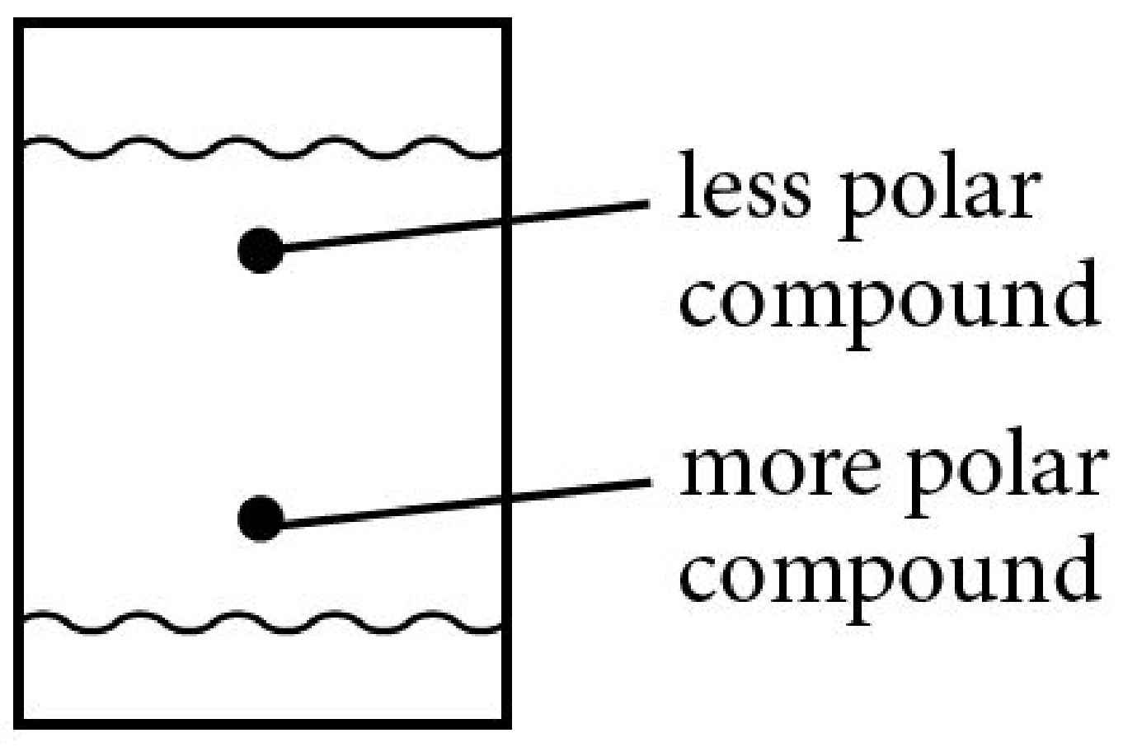
Ag^+ ions required to precipitate CrO_4^{2-}

$$= \left[\frac{K_{sp}(Ag_2CrO_4)}{0.05}\right]^{1/2} = \left[\frac{1.9\times10^{-12}}{0.05}\right] = 6.16\times10^{-6}$$

Ag^+ require to precipitate Cl^- is less. So, Cl^- ions will precipitate first.

11. **(d) :** Dipole moment of the compounds (A), (B) and (C) are given as 2.71 D, 1.59 D, 3.05 D respectively

More polar the compound is, the less it tends to be attracted to the less polar eluent and for the less time compound will be in mobile phase and obtained first.

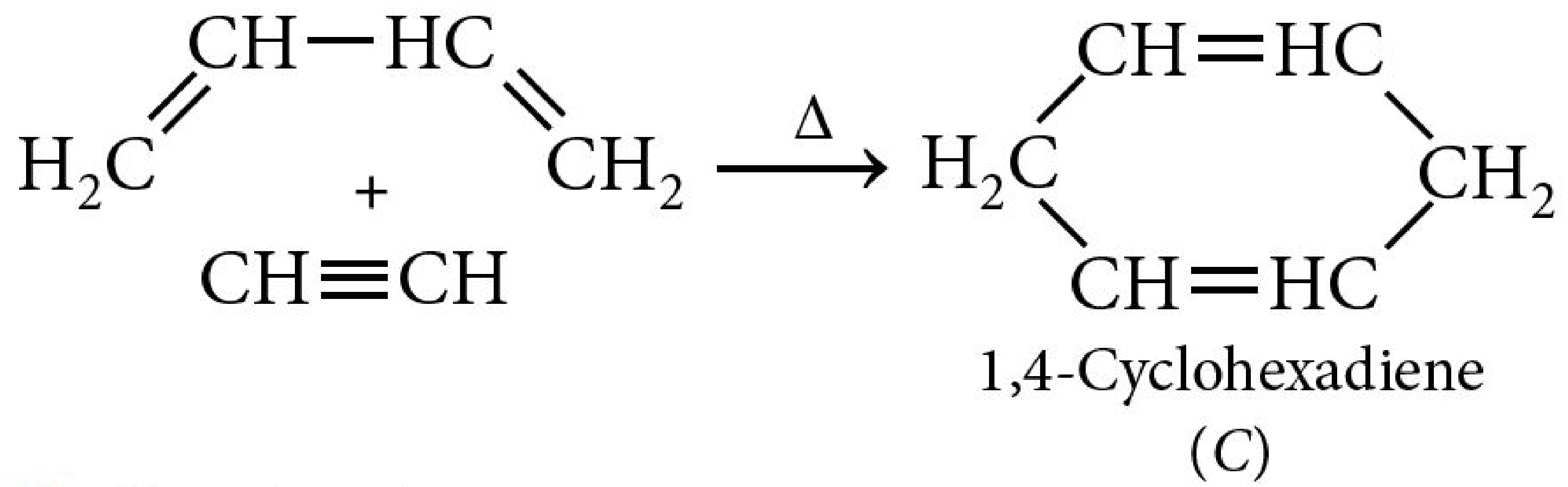


12. **(c)**

13. **(6) :** Cu_2Cl_2 reacts with NH_4Cl to form $[Cu(NH_3)_2]^+Cl^-$, which causes dimerisation of acetylene to give vinyl acetylene (*A*). Lindlar's catalyst ($Pd/BaSO_4$) and hydrogen reduces triple bond of (*A*) to form 1,3-butadiene (*B*). The last reaction involves the cyclisation of (*B*) with acetylene to form 1,4-cyclohexadiene (*C*).

$$CH{\equiv}CH \xrightarrow[NH_4Cl]{Cu_2Cl_2} \underset{\substack{\text{Vinyl Acetylene}\\(A)}}{CH_2{=}CH{-}C{\equiv}CH}$$

$$\xrightarrow{H_2 + Pd/BaSO_4} \underset{\substack{\text{1,3-Butadiene}\\(B)}}{CH_2{=}CH{-}CH{=}CH_2}$$



14. **(7) :** Bond orders :

$Li_2 = 1$, $He_2^+ = 0.5$, $N_2^+ = 2.5$, $N_2^{2-} = 2$, $O_2^+ = 2.5$, $O_2^{2-} = 1.0$, $O_2^- = 1.5$, $CO_3^{2-} = 1.33$, $C_6H_6 = 1.5$, $O_3 = 1.5$

15. **(–13538) :** $\Delta H^\circ = \Delta U^\circ + \Delta n_g RT$

As $\Delta n_g = (1 - 2) = -1$

$$\therefore \quad \Delta H^\circ = -20\times1000\ \text{J mol}^{-1} + ((-1)\times 8.314\ \text{JK}^{-1}\ \text{mol}^{-1}\times 298\ \text{K})$$

$$= -22477.572\ \text{J mol}^{-1}$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$$= -22477.572 - (298\ \text{K})\times(-30\ \text{J mol}^{-1}\ \text{K}^{-1})$$

$$= -13537.572\ \text{J mol}^{-1} \simeq -13538\ \text{J mol}^{-1}$$

◆ ◆

EXAM ALERT 2025

Exam	Date
TG EAPCET (Engineering)	2nd May to 5th May
NEET	4th May
CUET UG	Between 08 May and 01 June (Tentative)
COMEDK	10th May
JEE Advanced	18th May
SRM JEEE	Phase 2 : 12th June to 17th June Phase 3 : 4th July to 5th July
BITSAT	Session-1 : 26th to 30th May Session-2 : 22nd to 26th June
NDA II	14th September

GET SET GO *for* NEET

Class XII

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Practicing these questions helps to strengthen your concepts and give you extra edge in your NEET preparation

1. The correct equation for the degree of association 'α' of an associating solute, '*n*' molecules of which undergoes association in solution, is

(a) $\alpha = \frac{n(i-1)}{1-n}$ (b) $\alpha = \frac{i(n-1)}{1+n}$

(c) $\alpha = \frac{i(n+1)}{1-n}$ (d) $\alpha = \frac{i(n+1)}{n-1}$

2. In the electrochemical cell : $Zn|ZnSO_4(0.01\ M)||CuSO_4(1.0\ M)|Cu$, the emf of this Daniell cell is E_1. When the concentration of $ZnSO_4$ is changed to 1.0 M and that of $CuSO_4$ changed to 0.01 M, the emf changes to E_2. From the following, which one is the relationship between E_1 and E_2? (Given, $RT/F = 0.059$)

(a) $E_1 < E_2$ (b) $E_1 > E_2$

(c) $E_2 = 0 \neq E_1$ (d) $E_1 = E_2$

3. Match the column I with column II and choose the appropriate choice.

	Column I		Column II
(A)	Unit of *k* in third order	(1)	1/time
(B)	Unit of *k* in zero order	(2)	M/time
(C)	Unit of *k* in first order	(3)	$time^{-1}\ M^{-1}$
(D)	Unit of *k* in second order	(4)	$time^{-1}\ M^{-2}$

(a) A-2, B-3, C-1, D-4

(b) A-3, B-1, C-2, D-4

(c) A-4, B-2, C-1, D-3

(d) A-4, B-1, C-2, D-3

4. Both geometrical and optical isomerisms are shown by

(a) $[Co(en)_2Cl_2]^+$ (b) $[Co(NH_3)_5Cl]^{2+}$

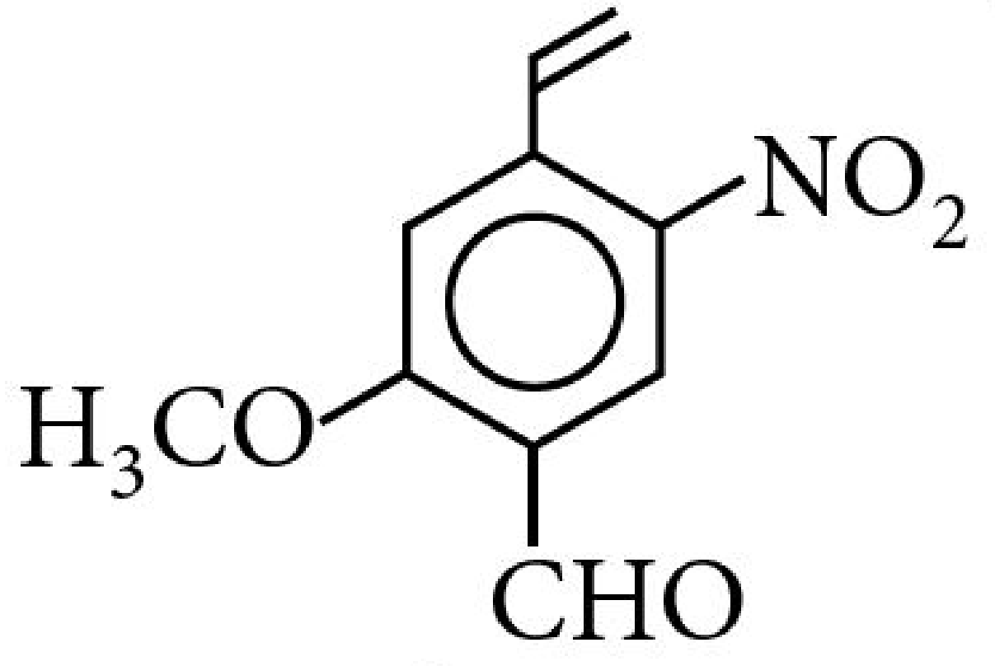
(c) $[Co(NH_3)_4Cl_2]^+$ (d) $[Cr(ox)_3]^{3-}$

5. Crystal field stabilization energy for high spin d^4 octahedral complex is

(a) $-1.8\ \Delta_o$ (b) $-1.6\ \Delta_o + P$

(c) $-1.2\ \Delta_o$ (d) $-0.6\ \Delta_o$

6. The IUPAC name of the following compound is



(a) 4-ethylene-2-methoxy-5-nitrobenzaldehyde

(b) 4-ethylene-6-methoxy-3-nitrobenzaldehyde

(c) 2-ethylene-5-formyl-4-methoxynitrobenzene

(d) 4-ethylene-5-nitro-2-methoxybenzaldehyde.

7. The colourless species among the following is

(a) VCl_3 (b) $VOSO_4$

(c) Na_3VO_4 (d) $[V(H_2O)_6SO_4]\cdot H_2O$

8. Ethanol is converted into ethoxyethane

(a) by heating excess of ethanol with conc. H_2SO_4 at 140°C

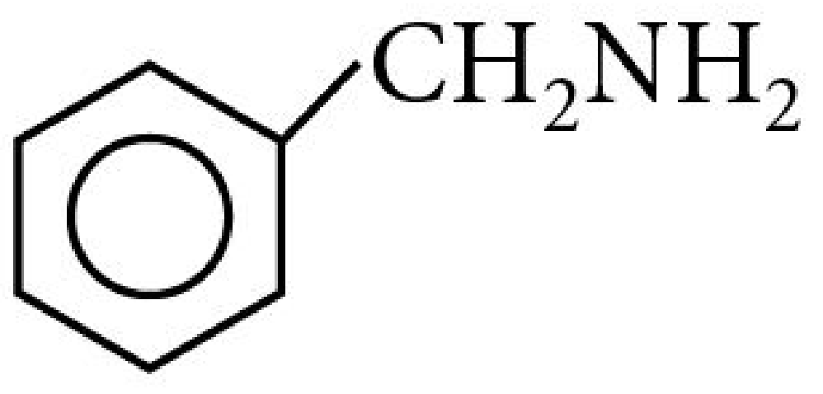
(b) by heating ethanol with excess of conc. H_2SO_4 at 443 K
(c) by treating with conc. H_2SO_4 at room temperature
(d) by treating with conc. H_2SO_4 at 273 K.

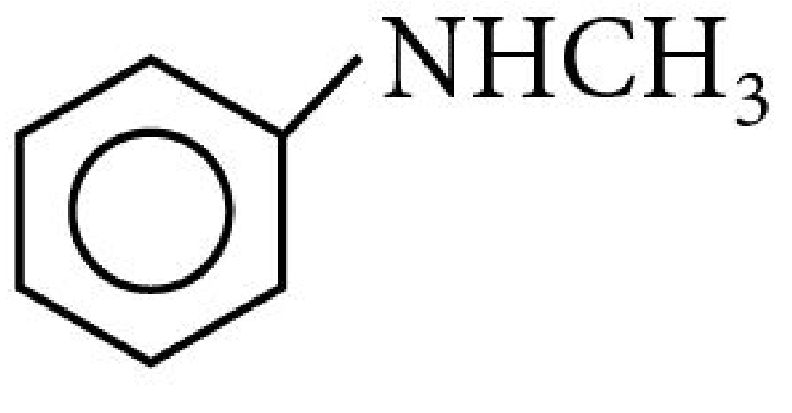
9. **Statement 1 :** Nitrogen is unreactive at room temperatures but becomes reactive at elevated temperatures (on heating) or in presence of catalyst.
Statement 2 : In nitrogen molecule, there is extensive delocalisation of electrons.
(a) Both statement 1 and statement 2 are correct.
(b) Statement 1 is correct but statement 2 is incorrect.
(c) Both statement 1 and statement 2 are incorrect.
(d) Statement 1 is incorrect but statement 2 is correct.

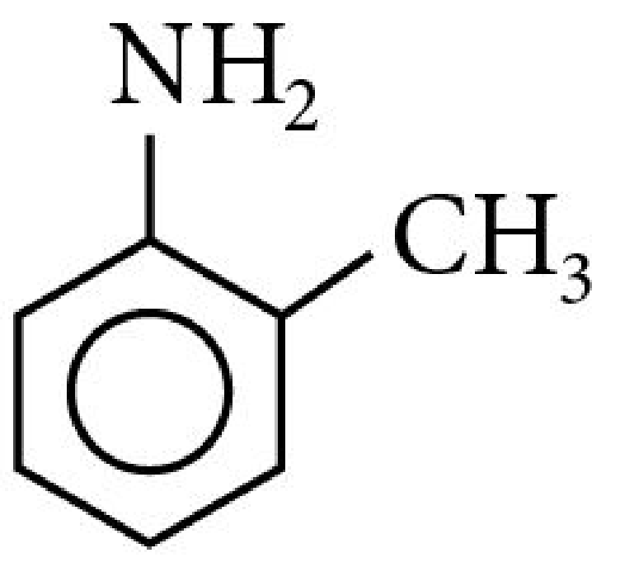
10. **Assertion :** Glyceraldehyde reacts with Br_2/H_2O to form achiral compound.
Reason : —CHO and —CH_2OH both are oxidized.
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

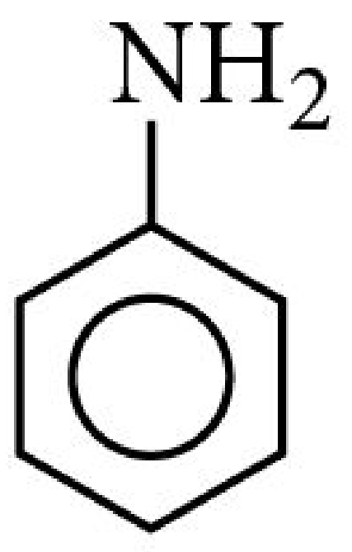
11. Read the following statements and choose the correct code
(i) S_N2 reaction proceed with complete stereochemical inversion.
(ii) S_N1 reaction proceed with racemisation.
(iii) A dextrorotatory compound rotate the plane polarised light to the left.
(iv) A laevorotatory compound rotate the plane polarised light to the right.
(a) TFTT (b) TTFF (c) FFTT (d) TFTF

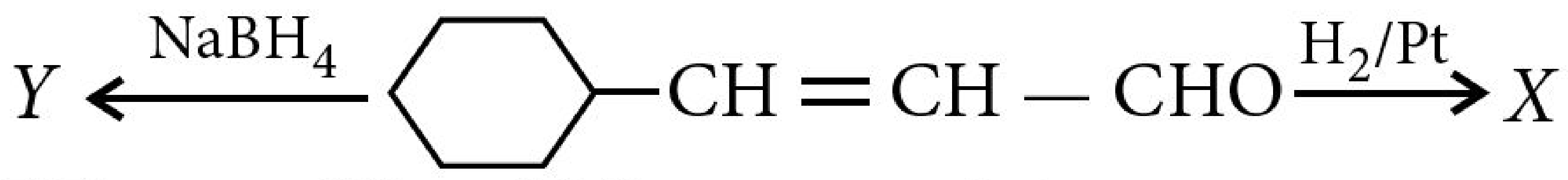
12. Which of the following is the strongest base?

(a)


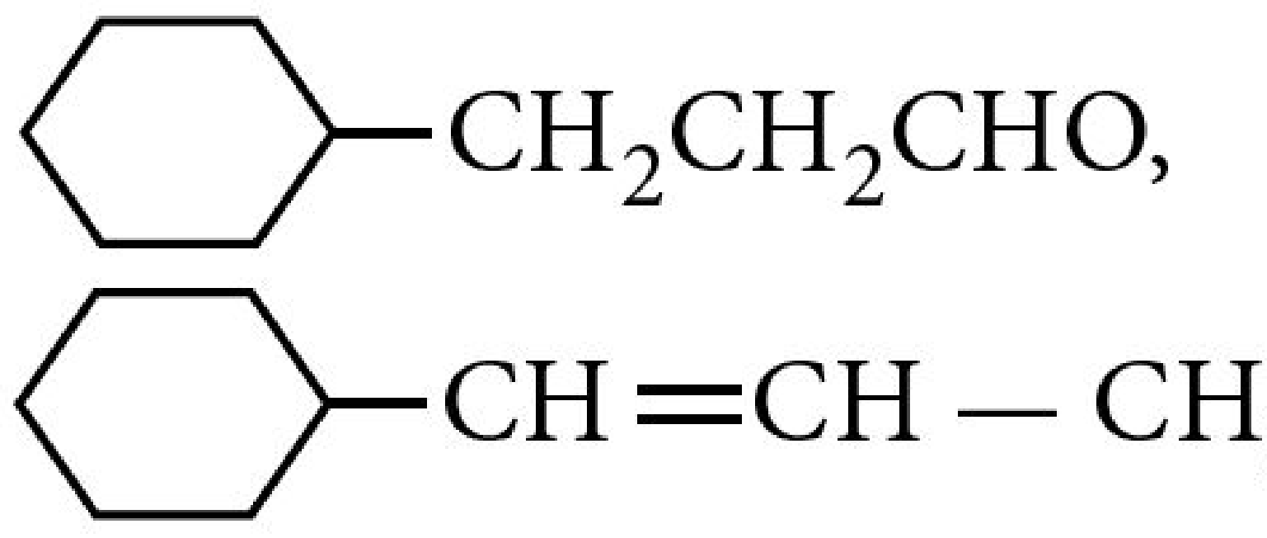
(b)


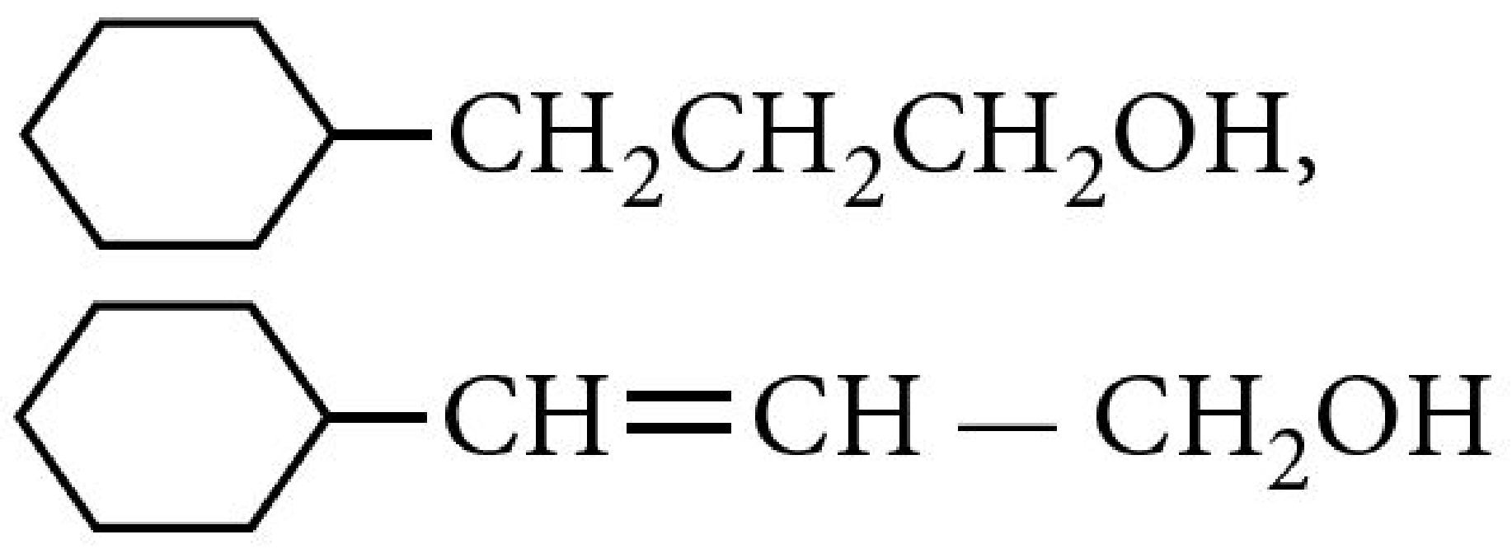
(c)


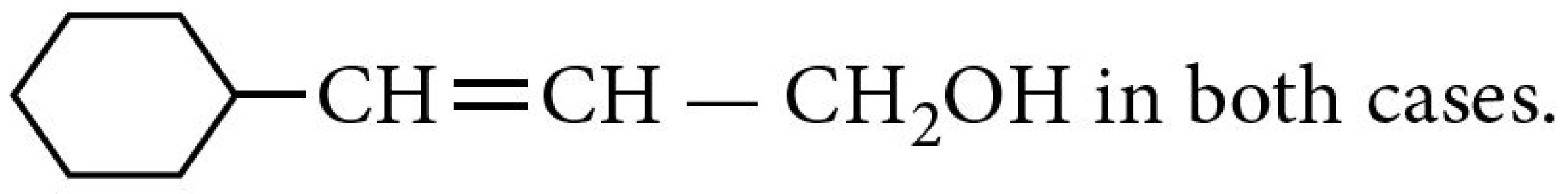
(d)


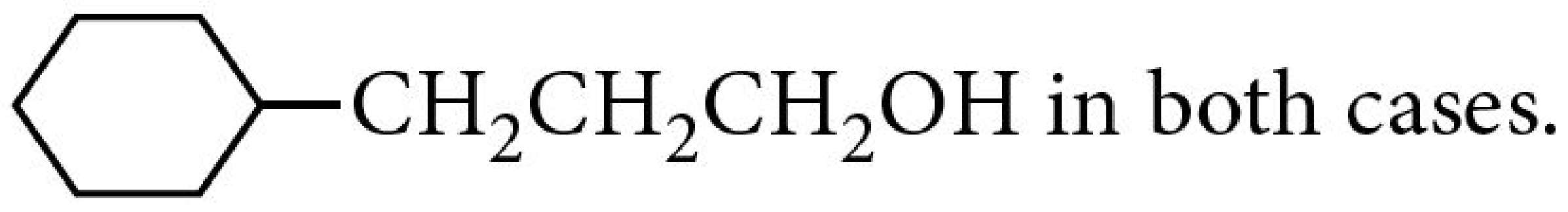
13.

Y
$NaBH_4$
CH = CH — CHO
H_2/Pt
X

What are '*X*' and '*Y*' respectively?

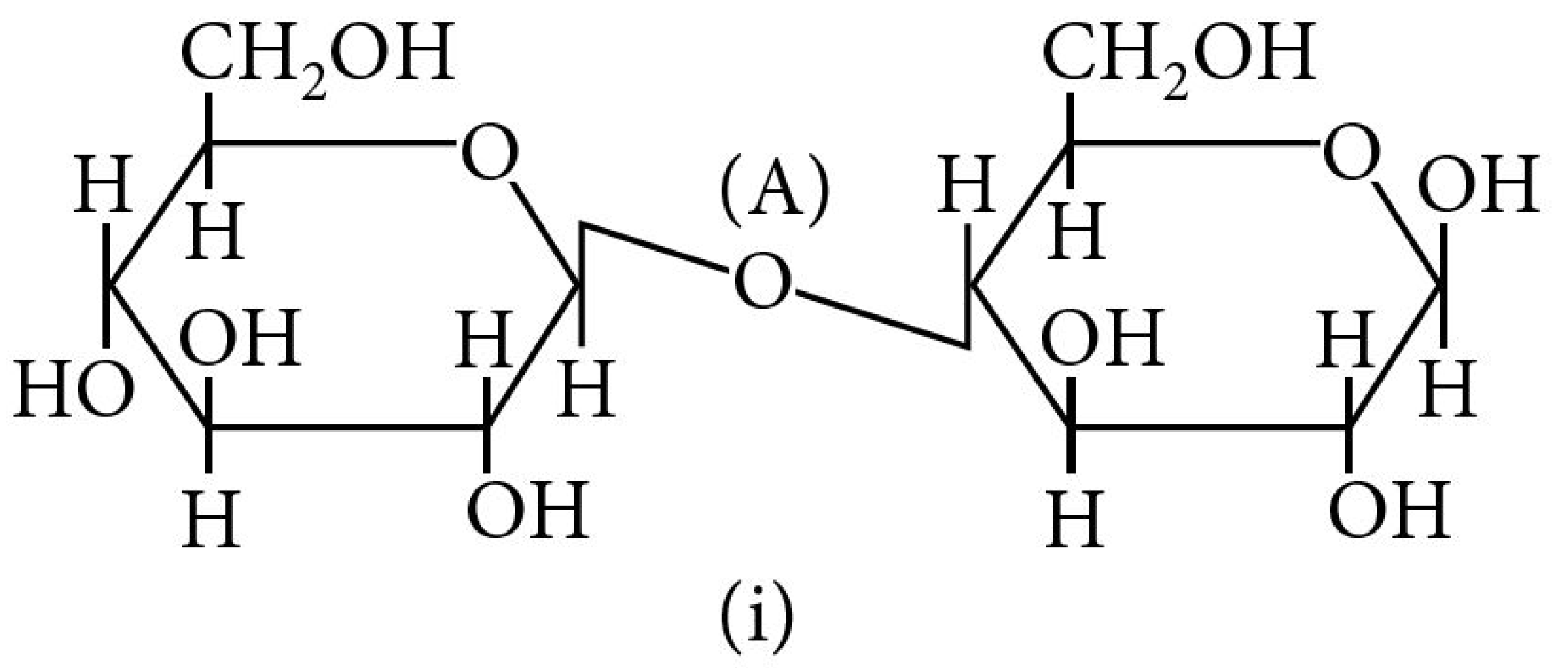
(a)

CH_2CH_2CHO,
CH = CH — CH_2 — OH

(b)

$CH_2CH_2CH_2OH$,
CH = CH — CH_2OH

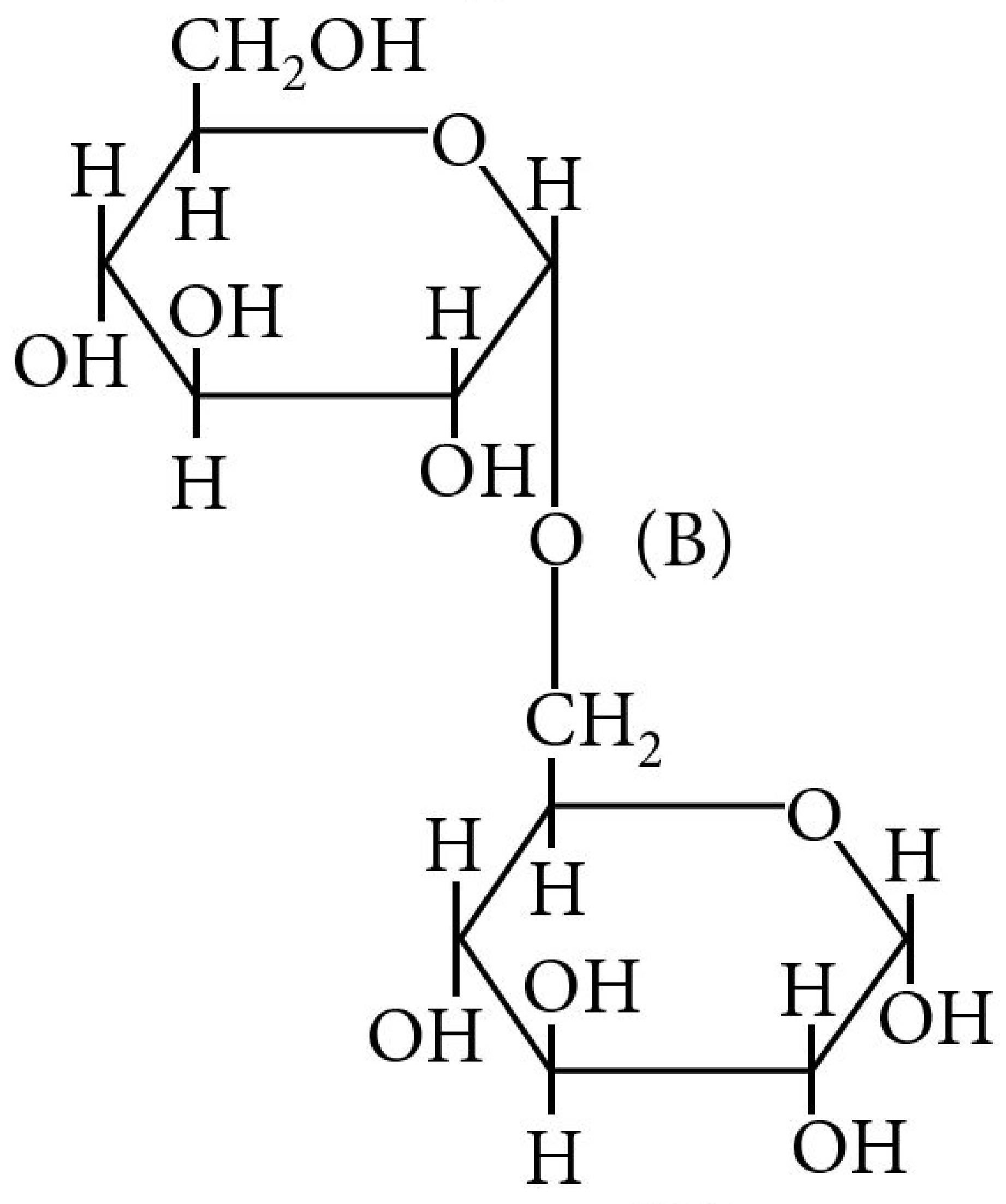
(c)

CH = CH — CH_2OH in both cases.

(d)

$CH_2CH_2CH_2OH$ in both cases.

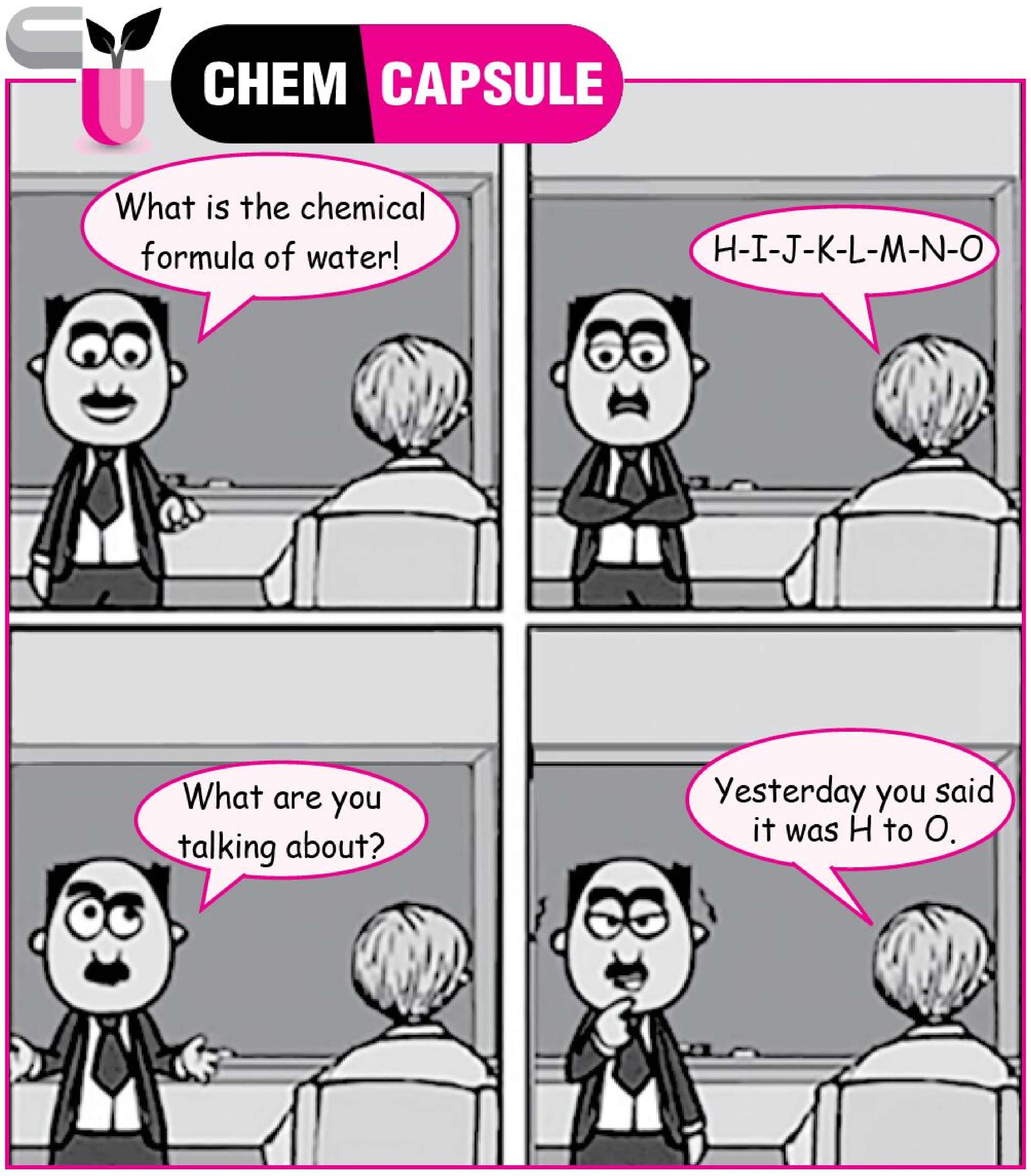
14. Three structures are given below in which two glucose units are linked. Which of these linkages between glucose units are between C_1 and C_4 and which linkages are between C_1 and C_6

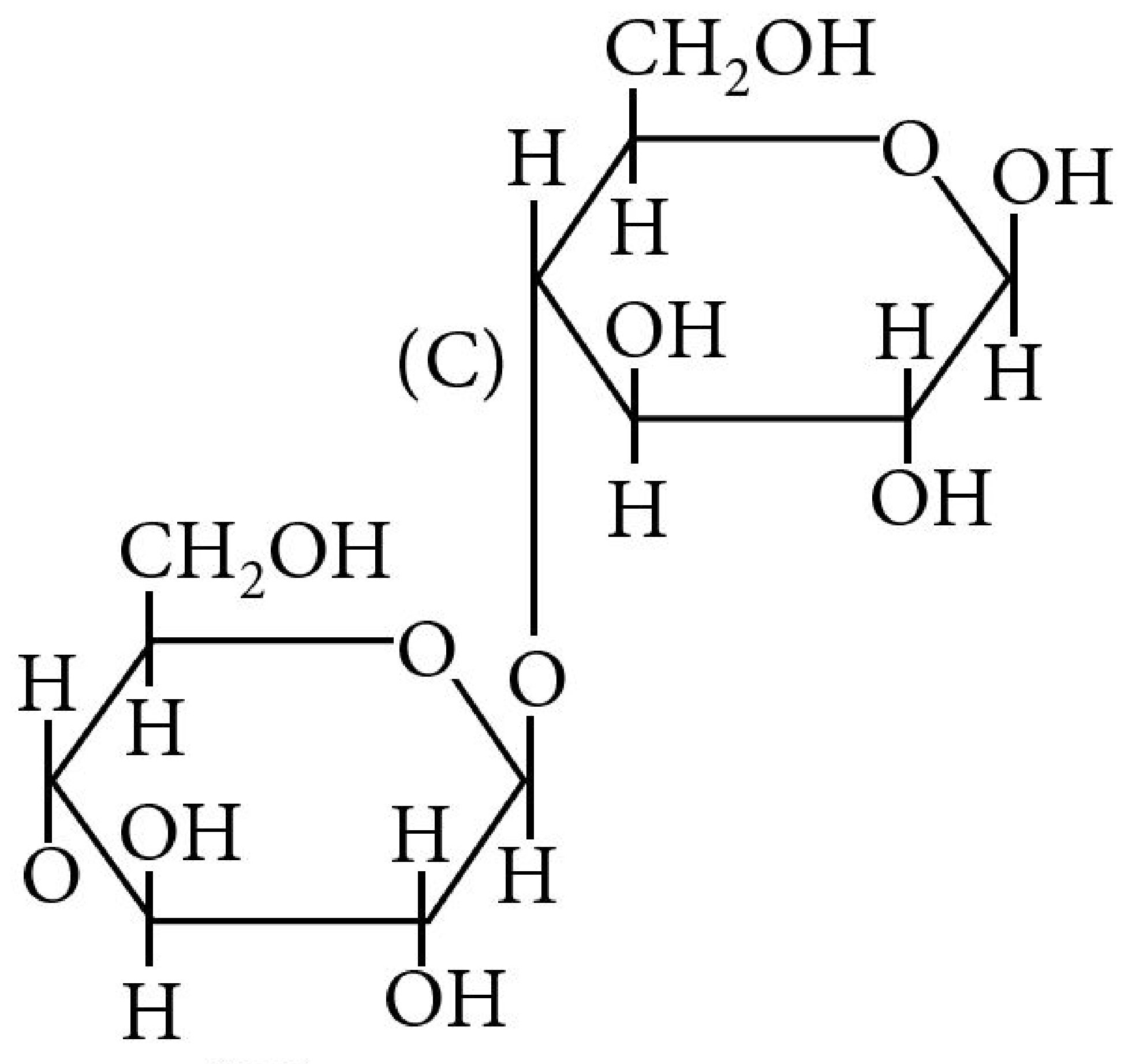

CH_2OH
CH_2OH
(A)
O
OH
HO
H
OH

(i)


CH_2OH
O
(B)
CH_2
OH
H

(ii)


CHEM CAPSULE
What is the chemical formula of water!
H-I-J-K-L-M-N-O
What are you talking about?
Yesterday you said it was H to O.



(iii)

(a) (A) is between C_1 and C_4, (B) and (C) are between C_1 and C_6

(b) (A) and (B) are between C_1 and C_4, (C) is between C_1 and C_6

(c) (A) and (C) are between C_1 and C_4, (B) is between C_1 and C_6

(d) (A) and (C) are between C_1 and C_6, (B) is between C_1 and C_4

15. Match the flame colours of the alkaline earth metal salts in the Bunsen burner.

(p) Calcium	1. Brick red
(q) Strontium	2. Apple green
(r) Barium	3. Crimson

(a) p-1, q-3, r-2
(b) p-3, q-1, r-2
(c) p-2, q-3, r-1
(d) p-1, q-2, r-3

SOLUTIONS

1. **(a) :** If n simple molecules of the solute A associate to form the associated molecule A_n so that we have the equilibrium :

$$nA \rightleftharpoons A_n$$

If α is the degree of association and we start with one mole of A, then at equilibrium

Number of moles of $A = 1 - \alpha$

Number of moles of $A_n = \alpha/n$

∴ Total number of moles $= 1 - \alpha + \alpha/n$

Since the colligative property is proportional to the number of moles of the solute present in solution,

therefore, van't Hoff factor, $i = \dfrac{1-\alpha+\dfrac{\alpha}{n}}{1}$

Hence, $\alpha = \dfrac{n(i-1)}{1-n}$

2. **(b) :** $E_{\text{cell}} = E^\circ_{\text{cell}} - \dfrac{0.059}{n}\log\dfrac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]}$

$$E_1 = E^\circ - \frac{0.059}{2}\log\frac{0.01}{1}$$

$$E_1 = E^\circ - \frac{0.059}{2}(-2) = E^\circ + 0.059$$

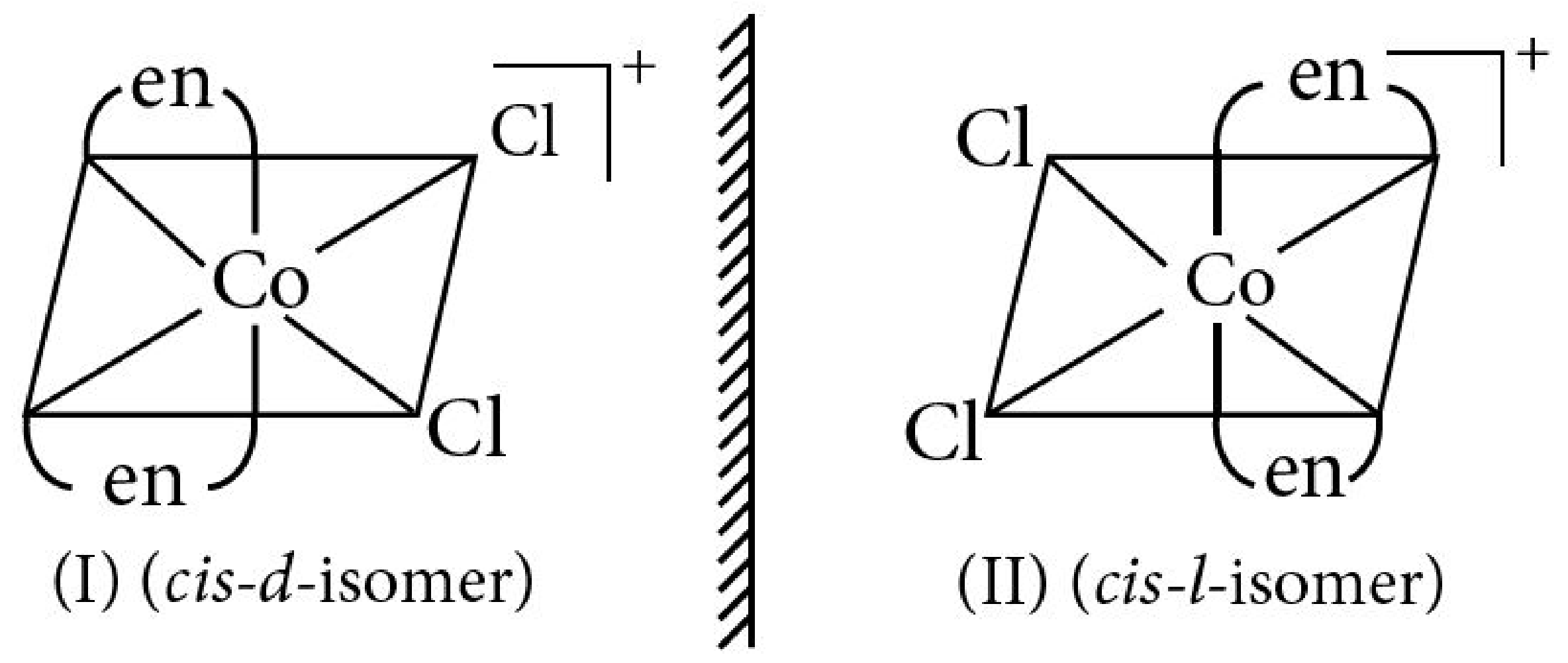
$$E_2 = E^\circ - \frac{0.059}{2}\log\frac{1}{0.01} = E^\circ - 0.059$$

Hence, $E_1 > E_2$

3. **(c) :** $k = \dfrac{\text{Rate}}{(\text{Concentration})^n} = \dfrac{\text{M/s}}{(\text{M})^n} = \text{M}^{1-n}\,\text{s}^{-1}$

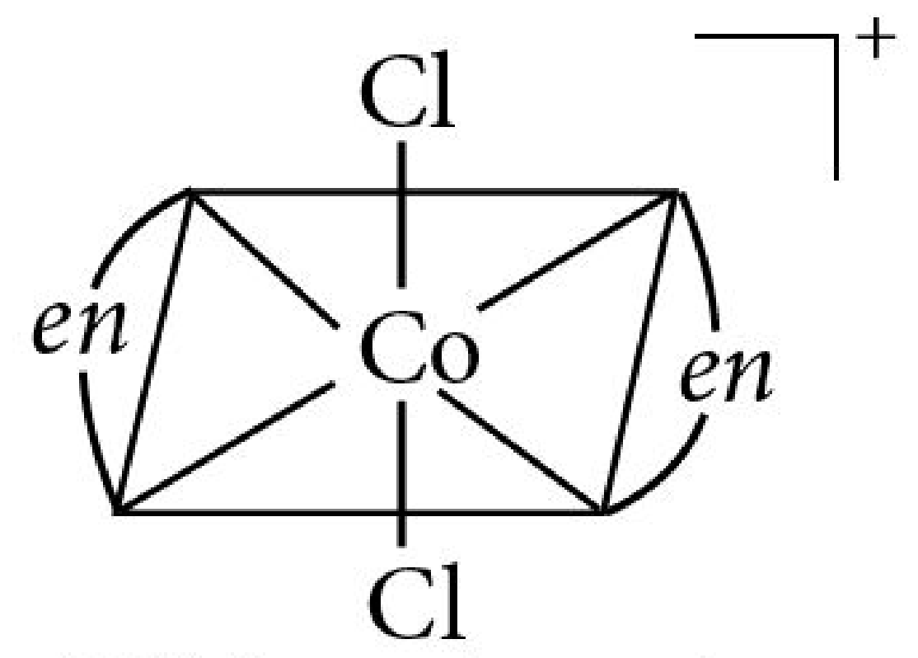
$n = 0$, unit of $k = \text{M s}^{-1}$
$n = 1$, unit of $k = \text{s}^{-1}$
$n = 2$, unit of $k = \text{M}^{-1}\,\text{s}^{-1}$
$n = 3$, unit of $k = \text{M}^{-2}\,\text{s}^{-1}$

4. **(a) :** $[\text{Co}(en)_2\text{Cl}_2]^+$ can show both types of stereoisomerism.



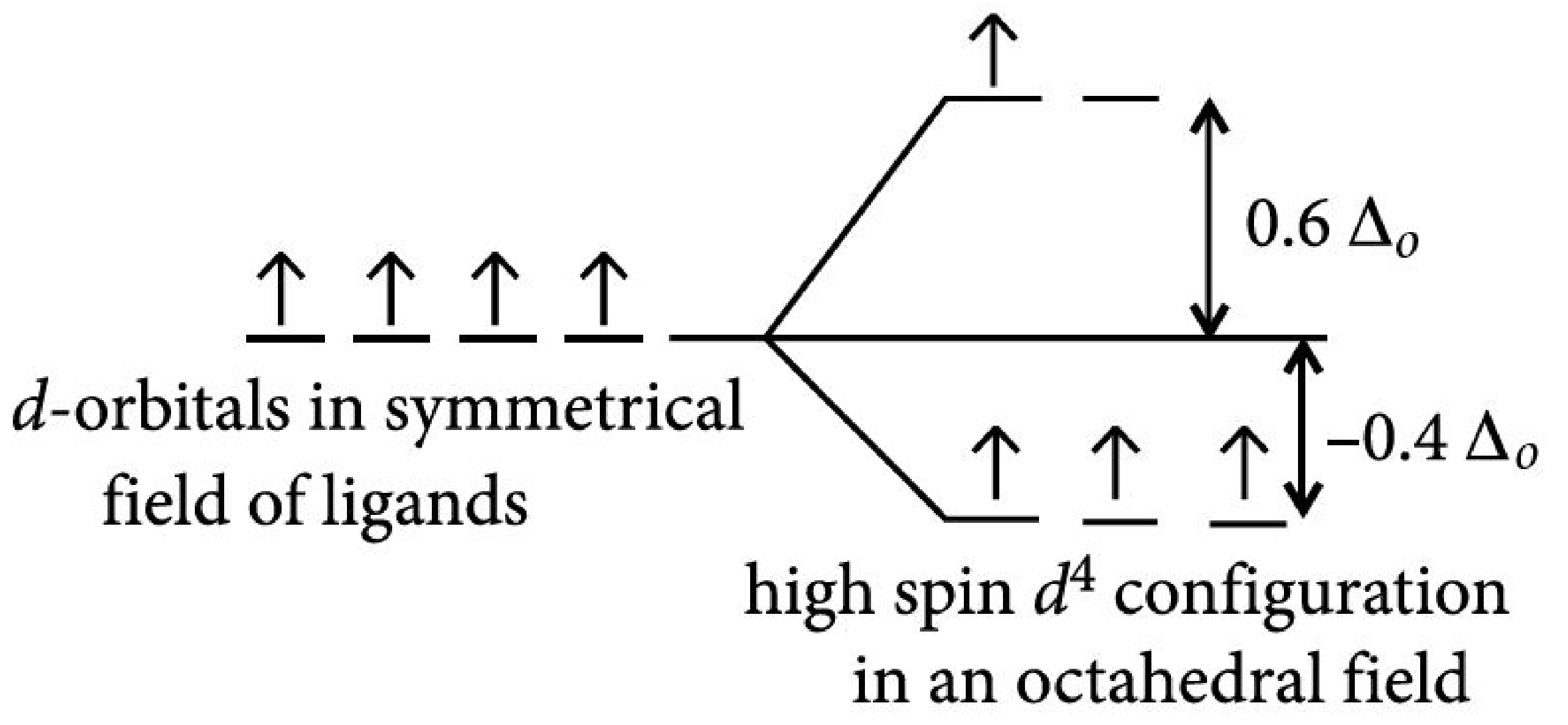
(I) (*cis-d*-isomer) (II) (*cis-l*-isomer)

Mirror



(III) (*trans* isomer)

5. **(d) :**


0.6 Δₒ
d-orbitals in symmetrical field of ligands
–0.4 Δₒ
high spin d⁴ configuration in an octahedral field

$$\text{CFSE} = 3(-0.4)\Delta_o + 0.6\Delta_o = -1.2\Delta_o + 0.6\Delta_o = -0.6\Delta_o$$

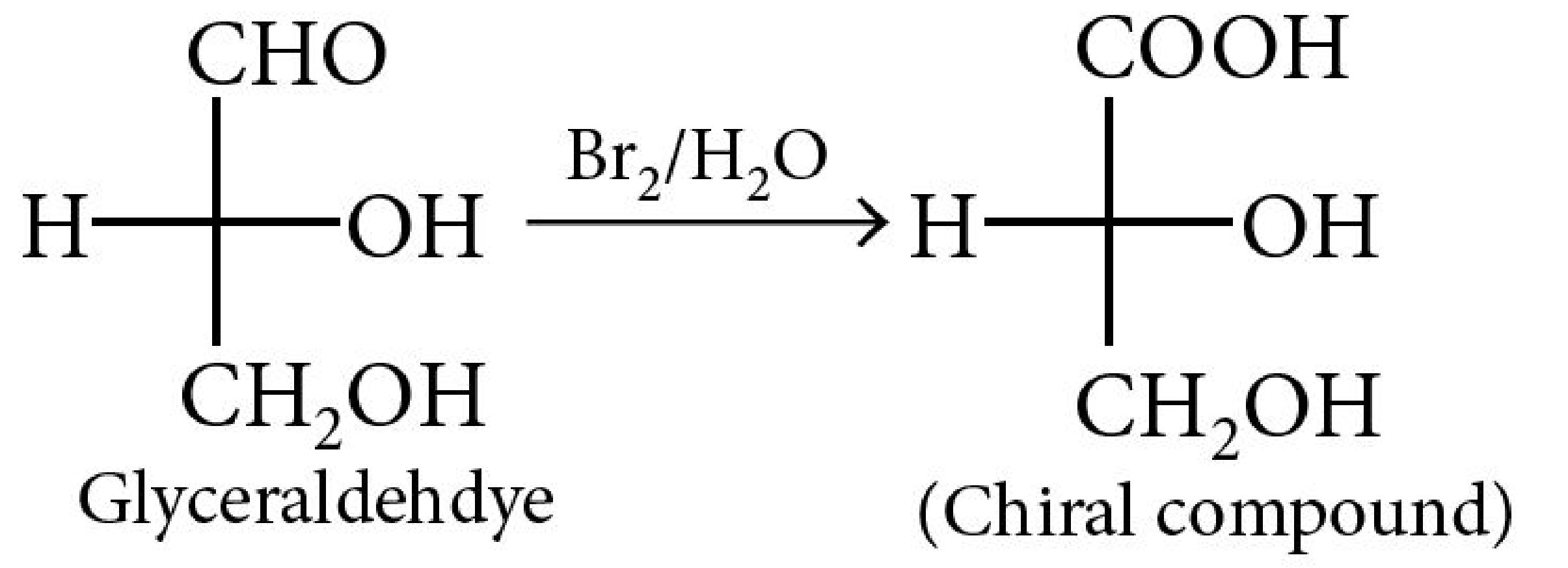
6. **(a)**

7. **(c) :** Na_3VO_4 contains vanadium in + 5 oxidation state which has vacant *d*-orbitals and is thus colourless.

8. **(a) :** $\underset{\text{Ethanol (excess)}}{CH_3CH_2OH} \xrightarrow[140^\circ C]{\text{conc. } H_2SO_4} \underset{\text{Ethoxyethane}}{CH_3CH_2OCH_2CH_3} + H_2O$

9. **(b) :** On heating, its outermost electron excite to next energy level by which it become more reactive.

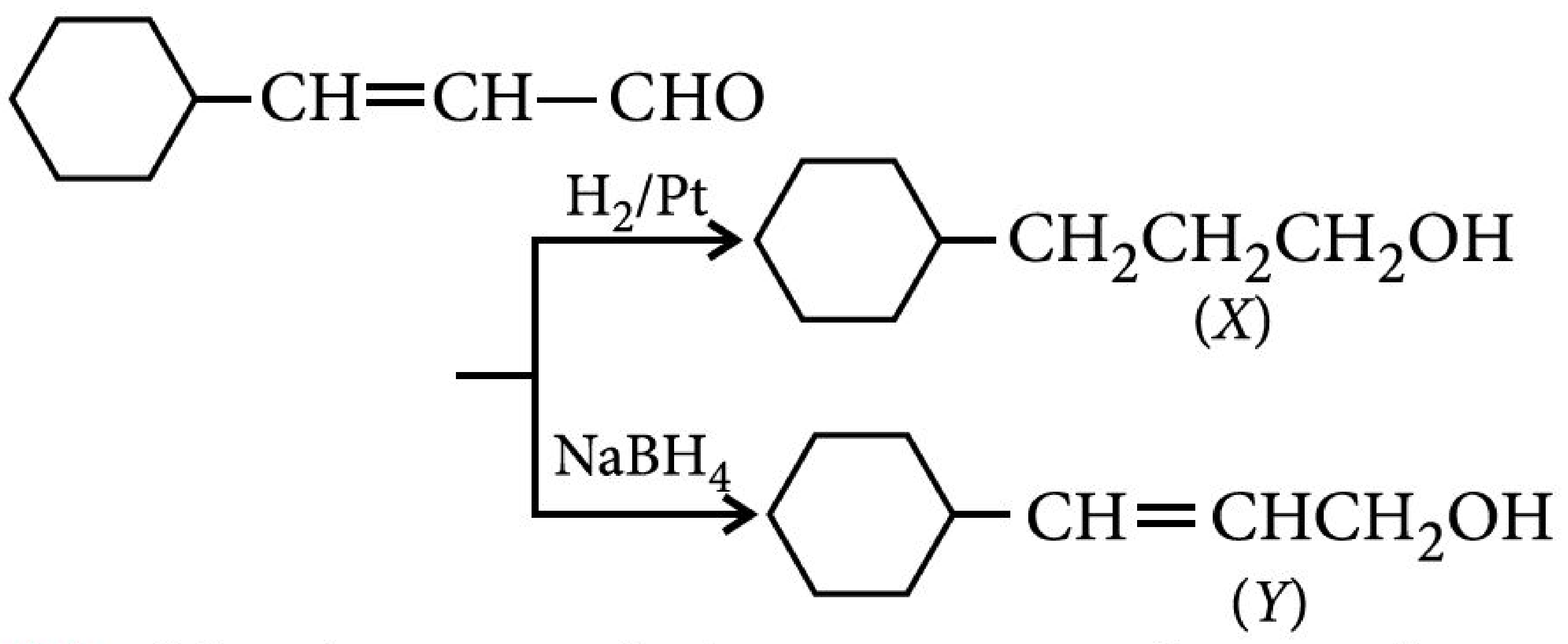
10. **(d) :** Only —CHO group gets oxidised to —COOH group by Br_2/H_2O.


CHO
H
OH
Br_2/H_2O
COOH
H
OH
CH_2OH
CH_2OH
Glyceraldehdye
(Chiral compound)

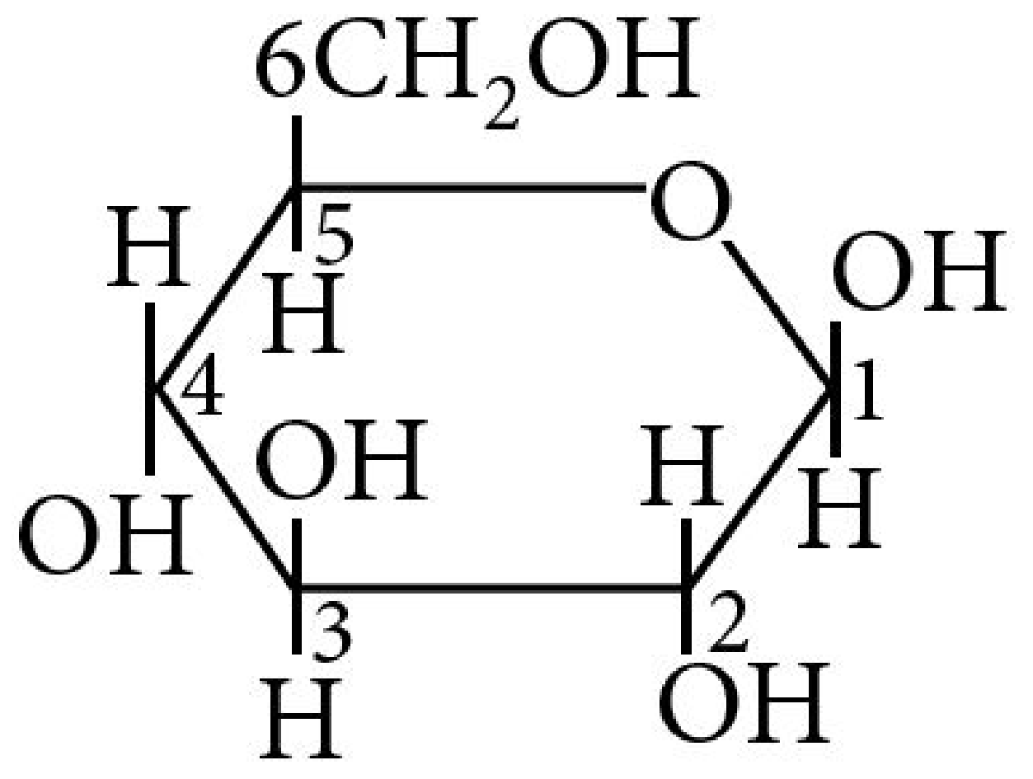
11. **(b) :** If the compound rotates the plane polarised light to the right, *i.e.*, clockwise direction, it is called dextrorotatory (Greek for right rotating) or the *d*-form and is indicated by placing a positive (+) sign before the degree of rotation. If the light is rotated towards left (anitclockwise direction), the compound is said to be laevorotatory or the *l*-form and a negative (–) sign is placed before the degree of rotation.

12. **(a) :** Aliphatic amines are stronger bases than aromatic amines.

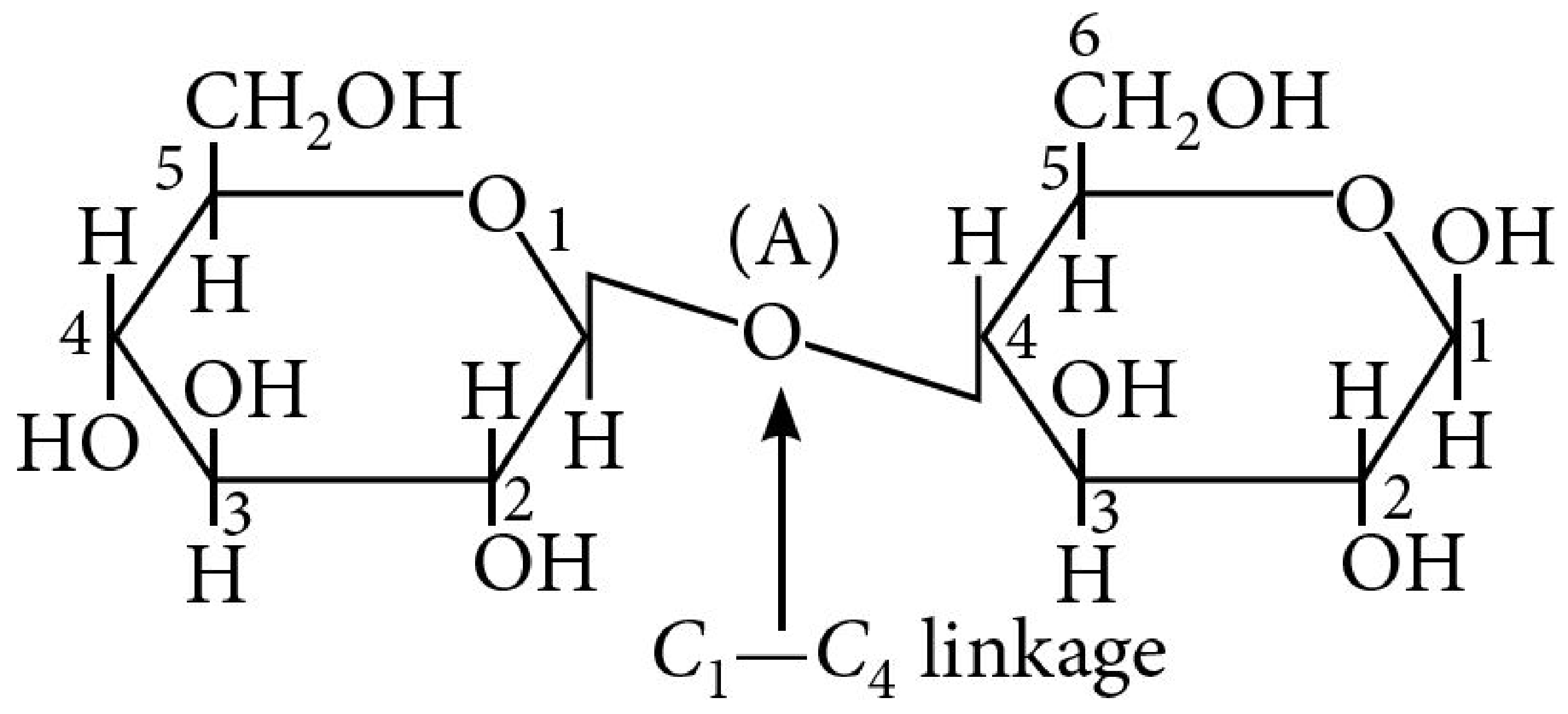
13. **(b) :** $NaBH_4$ selectively reduces —CHO to —CH_2OH and does not reduce $>C=C<$ to —CH_2—CH_2—. H_2/Pt reduces both —CHO and $>C=C<$ to —CH_2OH and —CH_2CH_2—, respectively.


—CH=CH—CHO
H_2/Pt
—$CH_2CH_2CH_2OH$
(X)
$NaBH_4$
—CH=$CHCH_2OH$
(Y)

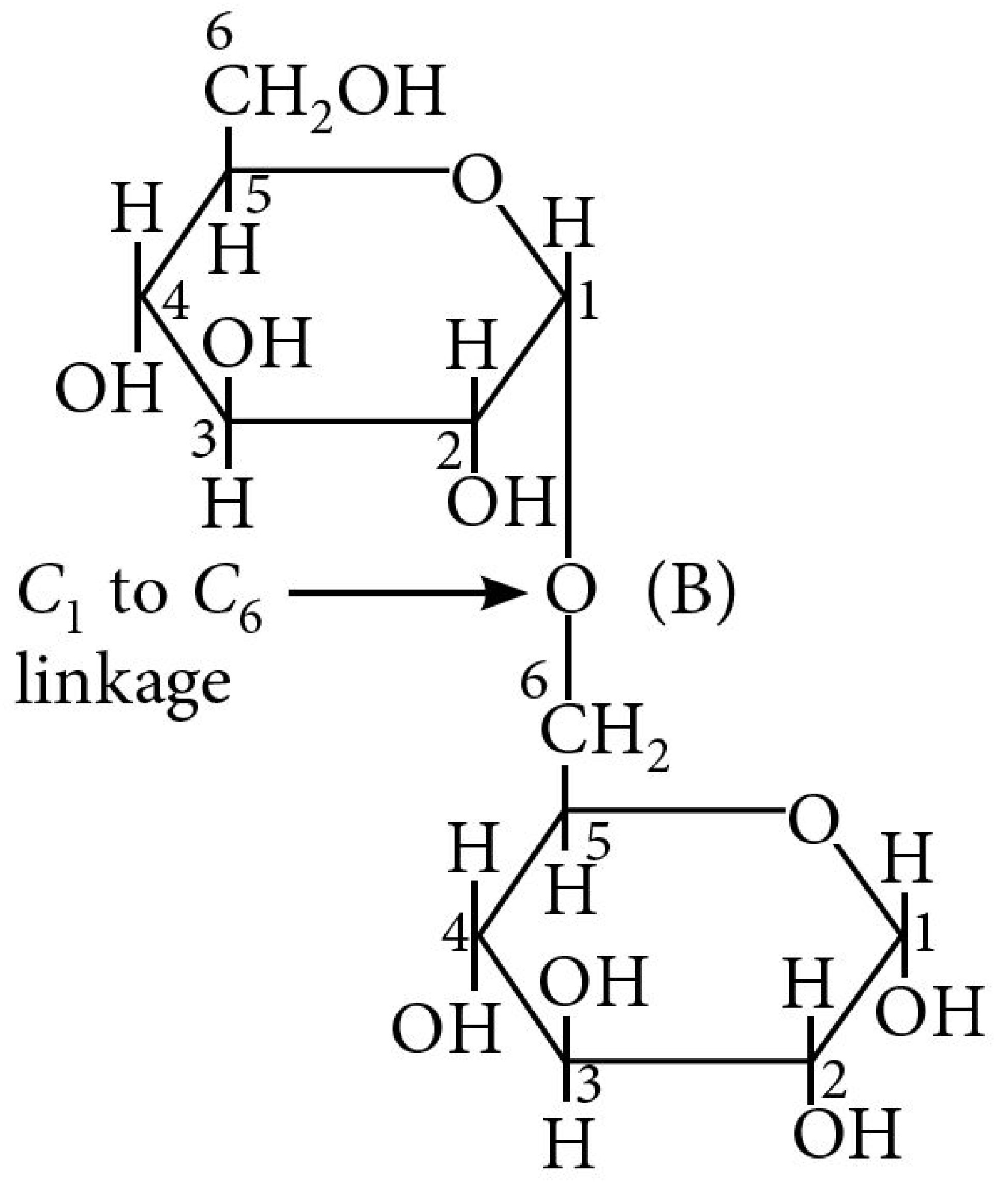
14. **(c) :** Numbering of glucose starts from adjacent carbon of O—atom to the other carbon atom ending at last CH_2OH group as shown below


6CH_2OH
O
OH
H
H
OH
H
OH
H
OH
H
1
2
3
4
5

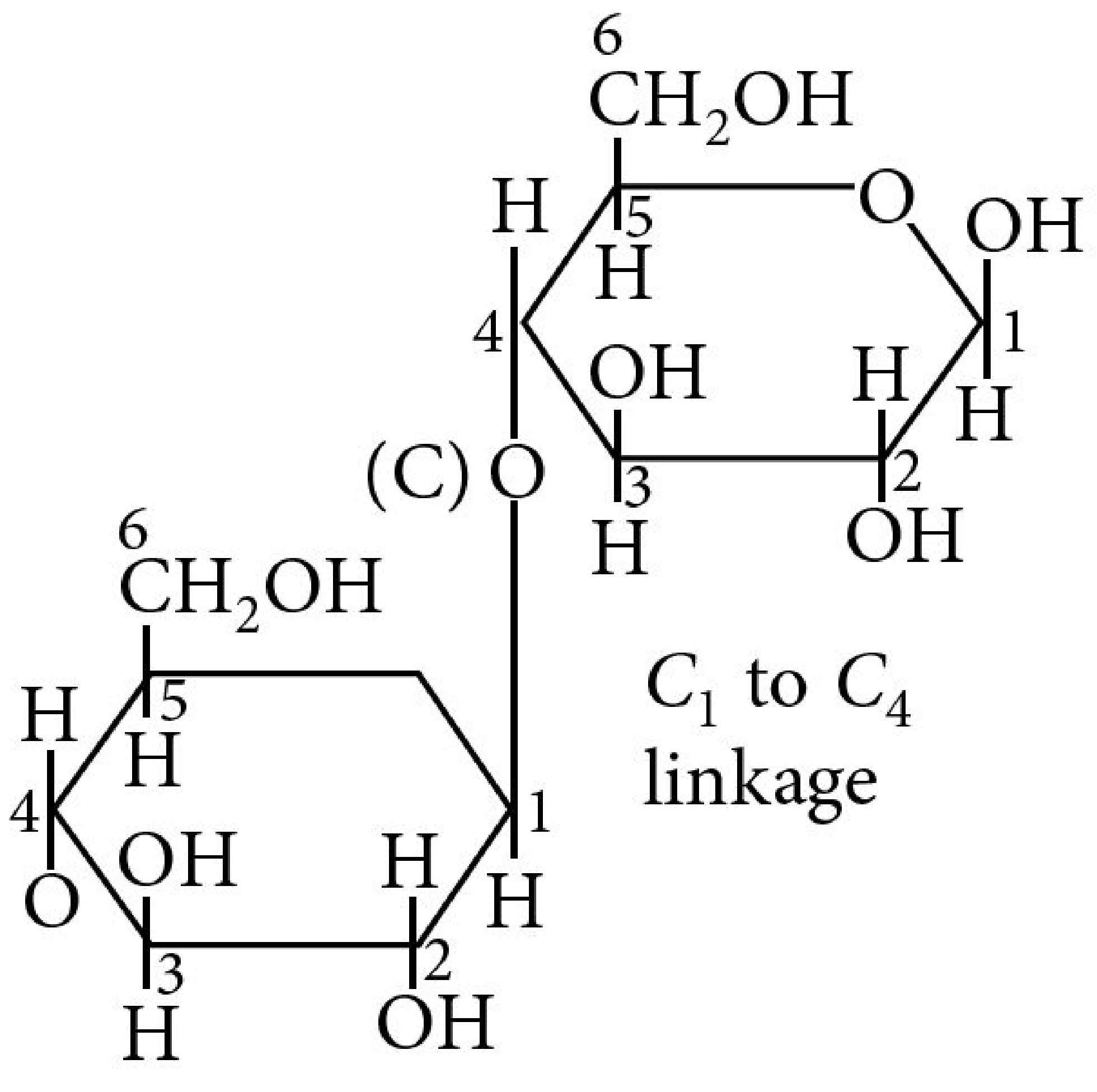
In this way, numbering for the disaccharides can be done as


CH_2OH
6
CH_2OH
5
O
1
(A)
O
HO
OH
H
C_1—C_4 linkage
1
2
3
4
5

(i)


6
CH_2OH
O
H
OH
H
C_1 to C_6 linkage
O
(B)
6
CH_2
O
OH
1
2
3
4
5

(ii)


6
CH_2OH
O
OH
(C)
O
6
CH_2OH
C_1 to C_4 linkage
O
H
OH
1
2
3
4
5

(iii)

15. **(a)**

◆ ◆

SOLUTIONS TO APRIL 2025 QUIZ CLUB

1. Quinol
2. Dimer
3. Phenol
4. Glycol
5. Adipic
6. Perchloric
7. Depolymerization
8. Potassium
9. Detonating
10. Inhibitors
11. Litharge
12. Triple point
13. Covalency
14. Isentropic
15. Weak, Strong
16. Reduction
17. Lyophilic
18. Hydrogen
19. 20
20. Blue

Winners : *Vedang, Arjun*

WORD GRID

Readers are
requested to send
their responses of
word grid.
Be the Winner!

Find and encircle the words in the given grid, running in one of the possible directions; horizontal, vertical or diagonal by reading the clues given below.

A	K	M	E	P	S	P	E	R	O	V	S	K	I	T	E
C	D	J	N	M	V	S	A	P	N	A	L	R	B	X	B
M	C	O	N	S	T	A	N	T	A	N	O	R	B	Q	K
J	Y	K	L	R	B	T	O	R	P	D	Q	Q	F	H	W
R	C	W	C	Z	T	R	G	C	T	A	B	V	D	V	V
E	L	A	M	I	N	O	V	D	V	H	P	R	L	J	U
N	I	U	V	S	A	P	Y	V	V	Q	T	A	A	G	T
V	S	T	O	R	P	I	V	W	R	W	M	R	R	C	G
Y	A	G	M	A	G	N	E	S	I	T	E	K	D	N	A
V	T	A	T	R	T	E	D	R	N	O	R	K	E	C	B
N	I	B	X	E	L	S	N	O	R	E	P	Y	H	R	S
B	O	S	Z	L	B	Z	T	A	M	T	R	C	A	Q	R
C	N	R	E	S	C	R	C	B	J	D	E	R	S	U	T
J	N	T	P	R	O	S	C	S	R	R	Y	A	O	A	A
O	X	Y	C	Y	A	N	O	G	E	N	K	M	C	Y	M
A	Z	P	Y	M	G	D	C	T	A	B	T	L	I	C	L

Clues

1. It is an alloy of 55% Cu and 45% Ni used in resistors and thermocouples.
2. It is a compound with molecular formula $C_{17}H_{23}NO_3$, used to dilate the pupil of the eye.
3. It is the process by which a straight chain compound changed into a cyclic compound.
4. It refers to any solid figure having twelve apices and each of its face is triangular. It is also found in derivatives like $B_{12}H_{12}^{2-}$
5. These are the elementary particles having mass about 2185 times that of the mass of an electron. These are found in cosmic radiations.
6. It is a carbonate mineral of magnesium.
7. A pseudohalogen, $(OCN)_2$ formed by the reaction of $KOCN + Cl_2$.
8. It is the name for the mineral ,$CaTiO_3$.

◆

Note :- Please send entries of solutions both with words and scanned copy of the grid by 10th of every month.

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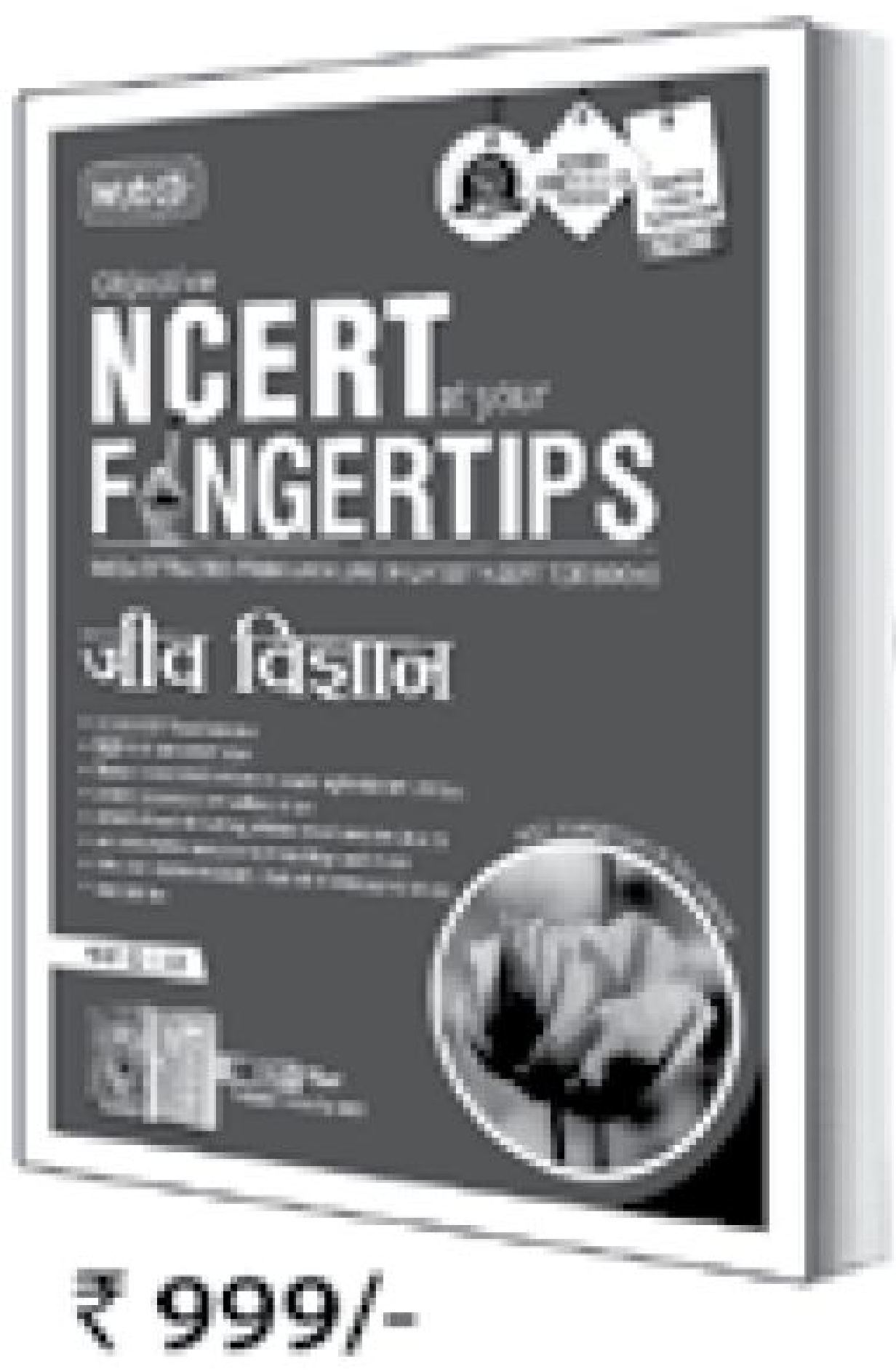

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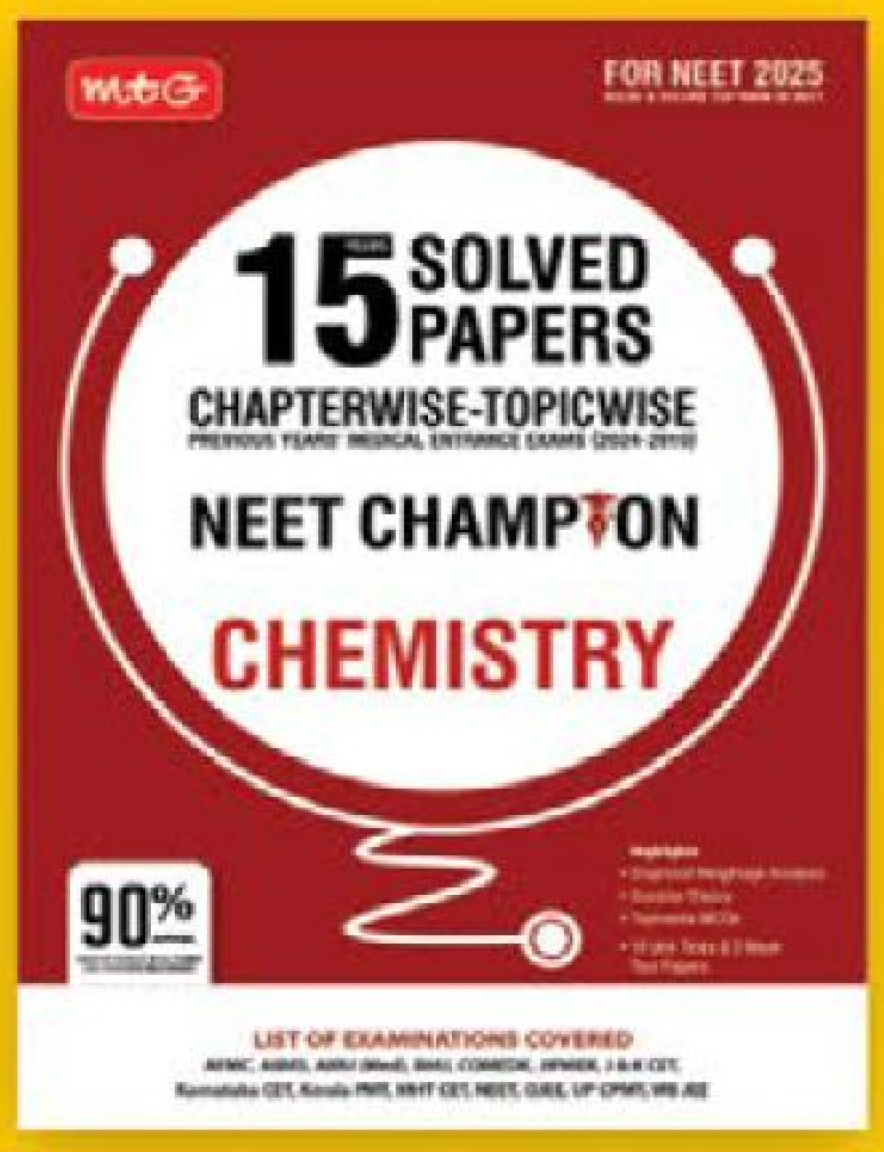
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Comprehensive Coverage of Exam Patterns

- Includes chapterwise topicwise solutions of CBSE PYQs (2025-2016) and 3 years of CBSE Sample Questions covering all question typologies (MCQs, VSAs, SAs, Case-Based Questions and LAs)

Effective Study Tools

- Essential Concepts/ Summary for quick conceptual clarity
- Brain Maps for recall and better retention
- Chapterwise Self-Assessments with a special section on Competency Focused Questions

Performance Enhancement Techniques

- Graphical Analysis helps identify high weightage chapters and topics
- Toppers' Answers provide insights into effective answer-writing techniques and Preparatory Tools to strengthen exam strategies

Practice & Exam Readiness

- 5 Practice Papers for exam practice and self-evaluation

Quick & Smart Revision Aids

- Multicolour Rapid Revision Hack Sheets for efficient last-minute revision
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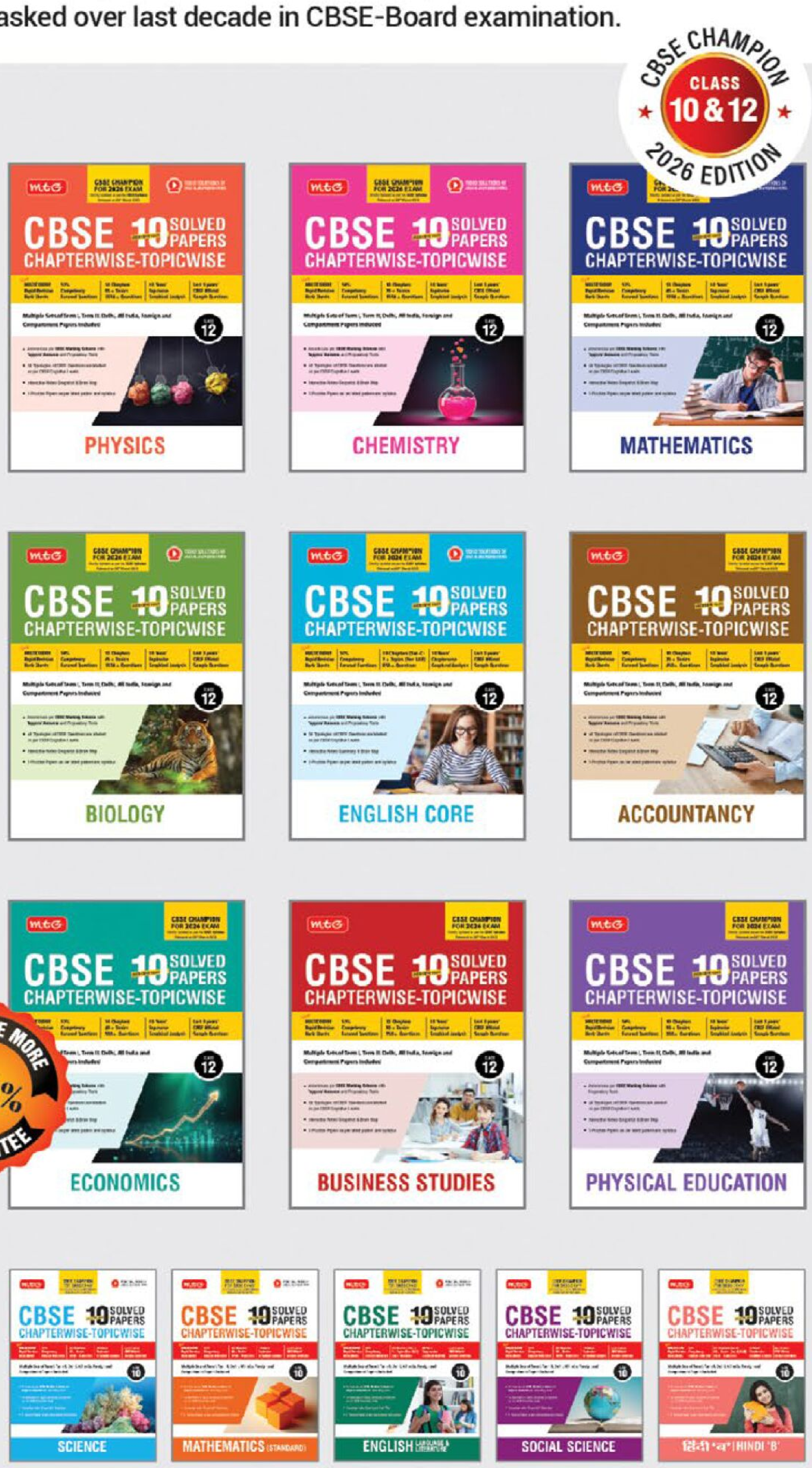

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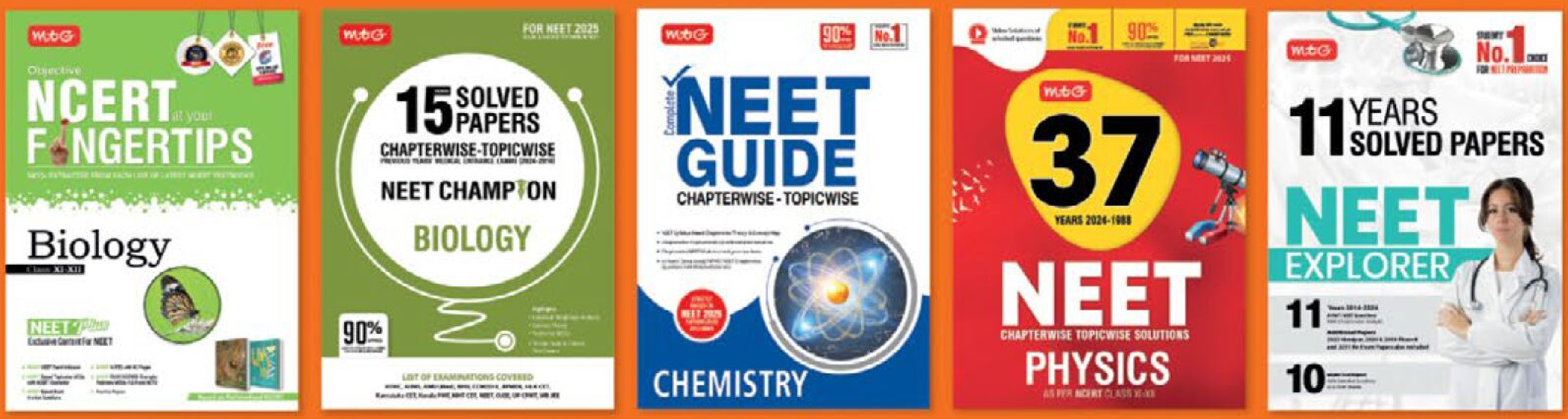
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